EIGHTEENTH YEAR OF PUBLICATION.

THE

JOURNAL OF SCIENCE,

AND ANNALS OF

ASTRONOMY, BIOLOGY, GEOLOGY, INDUSTRIAL ARTS, MANUFACTURES, AND TECHNOLOGY.

(MONTHLY, FORMERLY "THE QUARTERLY JOURNAL OF SCIENCE.')

Vol. III. (THIRD SERIES)
No. LXXXIX.

MAY
1881.

CONTENTS.

ARTICLES. PAGE

1. Scientific Arrogance. By ROBERT WARD 249
2. The Evolution of the Solar System. By CHAS. MORRIS 258
3. The Formative Power in Nature. By SIDNEY BILLING.. 269
4. Human Complexion and its Causes 277
5. Chemical Shams. By J. HEPBURN DAVIDSON 282
6. Explosives 287

ANALYSES OF BOOKS.

The so-called Understanding of Animals, or Animal Instinct .. 289
The Natural History of British Fishes.. 292

ANALYSES OF BOOKS—*continued.* PAGE

The Ventilation of Dwelling-Houses, and the Utilisation of Waste Heat from Open Fireplaces 294
General Physiology of Muscles and Nerves 297
Experimental Researches on the Temperature of the Head .. 296
The Collected Works of James MacCulIagh, LL.D., &c. .. 300
The Weather of 1880 as observed in the Neighbourhood of London 301
A Treatise on Fuel 301
CORRESPONDENCE 303
NOTES 306

LONDON:

3, HORSE-SHOE COURT, LUDGATE HILL.

Where Communications for the Editor and Books for Review may be addressed.

PRICE ONE SHILLING AND SIXPENCE.

TEXT-BOOKS OF SCIENCE.

In small 8vo., with 372 Figures on Wood, price 6s., cloth,

SYSTEMATIC MINERALOGY. By HILARY BAUERMANN, F.G.S., Associate of the Royal School of Mines. (Forming one of Messrs. LONGMANS & Co.'s Series of *Text-Books of Science, Mechanical and Physical*, edited by C. W. MERRIFIELD, F.R.S.)

London: LONGMANS & CO.

CROWN 8VO., PRICE 1S.

LIFE AND MIND:

ON THE BASIS OF MODERN MEDICINE.

BY ROBERT LEWINS, M.D.

WATTS & CO., 84, FLEET STREET, LONDON.

SOLAR PHYSICS.

THE following COURSE OF LECTURES will be given by Members of the Committee on Solar Physics appointed by the Lords of the Committee of Council on Education:—

Six Lectures on Spectroscopy in relation to Solar Chemistry. By Mr. J. NORMAN LOCKYER, F.R.S., 4th, 6th, 11th, 13th, 18th, and 20th May.

Three Lectures on the Photography of the Infra-red of the Spectrum in its application to Solar Physics. By CAPTAIN ABNEY, R.E., F.R.S., 25th and 27th May, and 1st June.

The Lectures will be delivered in the Lecture Theatre of the South Kensington Museum, at 4 p.m., on the days stated above.

Admission will be by Tickets, which may be obtained as far as there is room on application, by letter, to the Secretary, Science and Art Department, South Kensington, S.W.

For Electric Bells, Indicators,

and everything appertaining to

ELECTRICAL ENGINEERING,

Apply to

JULIUS HINTZE, Electrician, &c.,

EAGLE HOUSE, EAGLE WHARF ROAD, N.

THE

JOURNAL OF SCIENCE.

MAY, 1881.

I. SCIENTIFIC ARROGANCE.

By Robert Ward.

THEOLOGIANS and their followers not unfrequently complain of the arrogance of men of science; to which it has been replied that "No class of men, however highly instructed, is wholly free from faults of judgment and taste, and there is no reason for expecting men of science to be more than human in this respect." And it may be at once conceded that the arrogance of men of science is quite equalled by the dogmatism of professors of religion; but I would respectfully suggest that the one is more excusable than the other. The scientist prides himself upon being guided by reason as exercised by observation of Nature; the religionist confessedly relies upon authority as represented by the Church of his Fathers, to which he turns for guidance on all difficult questions. The one may be said to believe in himself or his own powers of discernment; the other humbly, though it may be blindly, follows what he believes to be the wisdom of his ancestors. Positiveness of opinion is therefore excusable in the religionist, because founded in modesty; but when the scientist, abandoning reason, appeals to prejudice, he certainly indulges in an arrogance which may be described as wholly indefensible, because founded in conceit. I can best illustrate my argument by reference to an example. I happen to be the unfortunate author of a book entitled "The Constitution of the Earth," of which the following is a criticism:—

"Mr. Robert Ward's book is one of those odd argumentative works which the late Professor De Morgan would

undoubtedly have included in his 'Bundle of Paradoxes.' Mr. Ward's particular paradox consists in a belief that the world and the solar system generally are growing bigger. Those misguided authorities, the astronomers, from Laplace downward, have been of opinion that they were contracting; but Mr. Ward has changed all that, and 'shows cause' why they are now and have always been expanding. The planets, it seems, are little orbs knocked off from the Sun; and they are receding from it, instead of slowly approaching it, as the physicists vainly talk. The older a planet is, the farther has it got from the Sun. Moreover, it picks up a satellite or two on the way; and the age of a world may thus be roughly guessed by observing how many moons it has managed to annex. As planets become older they become hotter. 'Growing old is growing cold,' says the ancient proverb; and certainly the accepted doctrine that heat radiates would seem to lead towards the same conclusion; but Mr. Ward has changed all that too, and announces that the crust of the Earth is cracking, not because of contraction in the molten centre, but because of expansion. Altogether physical science is turned upside down by him with a boldness and originality quite remarkable. Chemists, physicists, astronomers, and biologists are all equally wrong. Matter is constantly coming into existence and passing away. Sunbeams add many thousand tons annually to the Earth's weight. Rain falls from the sky direct, and is not, as meteorologists absurdly assert, a product of evaporation. And so forth. All this is very excellent fooling; but there is a method in Mr. Ward's madness none the less. In spite of profound ignorance of many simple chemical and physical facts, gleams of real cleverness burst out here and there: while you have only to reverse exactly all that he says about the solar system, and you get a forcible and in many ways original summary of the current nebular hypothesis. If Mr. Ward were possessed of a really scientific training he would probably have made a bold and vigorous inquirer; as it is, he has only succeeded in producing an exceedingly absurd and extravagant work."

As the publication from which I have quoted is accustomed to insert letters, I addressed the following to the editor, in the hope that he would allow me to show that my book was not quite so "absurd and extravagant" as it was represented:—

"Sir,—Will you kindly permit me to correct a mistake into which your reviewer has fallen when noticing my book, 'The Constitution of the Earth,' a few days ago? He

represents my conclusions as at variance with those of scientists in general. Of course, to the extent that a book contains anything original, it must differ from the opinions expressed by other writers; but I believe that what is described as 'the evolution of species' is a very commonly-accepted doctrine of scientists at the present time. My book might have been appropriately enough entitled 'The Evolution of the Earth.' It simply assumes that the same laws which have been observed in the creation of species have also been concerned in the origin and development of the globe upon which they stand; that, in short, the evolution of species has been part of a great scheme of creation by which the Earth itself has undergone a progressive development. And certainly this conclusion is not inconsistent with the general teaching of geologists, who assume that the *conditions* fitted for the existence of a higher development of animal and vegetable life must have preceded their actual existence on the Earth. It is true that I do not believe in the *theory* of some modern astronomers who think that the Earth and all the other planetary bodies are destined to drop into the Sun; but, as a matter of *fact*, the latest measurement of the Earth's distance from the Sun in connection with the transit of Venus is entirely confirmatory of my view of creation, and shows that the Earth is *receding* from the Sun. And previous measurements supported the same conclusion."

I think it will be allowed that my language could not have been more conciliatory and temperate, and yet I have waited in vain for the publication of my letter. It is obvious that my critic professes to be "a man of science." Indeed he must have fathomed the depth of my "ignorance of many simple chemical and physical facts," or otherwise he could not have discovered the extent of their profundity,—an intellectual exploit which fills me with astonishment. Certainly it would be difficult to give an account of my book more illustrative of scientific arrogance or more calculated to mislead the reader as to its true character. Instead of relying upon reason and observation to confute my "very excellent fooling," he appeals to prejudice throughout, and presents the reader with a garbled and fanciful account of the contents of my book. I am represented as wholly at variance with "chemists, physicists, astronomers, and biologists," whilst in reality the views I have propounded are largely supported by quotations from writers in the several departments of science; so much so that my fault has been described by a friendly critic as "over-quotation." It is

true that science is full of paradoxes; hence the continuous stream of new books, which are all in some degree at variance with "received opinion," and therefore more or less paradoxical. I flatter myself that the views I have enunciated in my book may be found to reconcile many interpretations of Nature hitherto considered antagonistic, and, in particular, I believe that I have done something towards reconciling the fundamental truths of religion and science.

My critic represents me as declaring unconditionally that "matter is constantly coming into existence and passing away." It is true that, in answer to Prof. Haeckel, I say that "Really experience—that is the knowledge communicated to our consciousness through the senses—is continually showing us matter in the process of coming into existence and passing away. That a natural body, when 'it seems to disappear,' does not actually disappear, is a pure theory. Abstract matter—that is matter devoid of every quality by which matter is known to us—never disappears, for the simple reason that it is an abstraction, and has no more sensible existence than any other metaphysical conception." I believe that Mr. Herbert Spencer and Prof. Huxley would both support me in this conclusion. I am also reported as asserting that "Sunbeams add many thousand tons annually to the Earth's weight. Rain falls from the sky direct, and is not, as meteorologists absurdly assert, a production of evaporation." I do so say that the light of the sun has been an important factor in the formation of the coal-measures, and, with George Stephenson, I am disposed to describe coal as "bottled-up" sunshine. Rain certainly "falls from the sky direct," whatever meteorologists may say as to the process by which it gets there. Chemists tell us that water is composed of two gases, and Laplace taught that the solar system was formed out of a gaseous fluid which occupied interstellar space.

The religionist says that science is a paradox; the scientist says that religion is a paradox. Which is right? I do not believe that either is literally accurate, but I do say that they are fundamentally reconcilable. The biologist and the geologist both say that life on the Earth has undergone a progressive development, and the latter concludes that such could only arise from a corresponding improvement in the condition of the Earth itself; but my critic, who is profoundly acquainted with the nature of heat, paradoxically assumes that the Earth is growing colder, and that man and all living things are destined to be frozen out of existence

and the Earth itself swallowed up by the Sun! As a matter of fact, when a base line has been measured a second time after the lapse of years, it has been found longer. If we may rely on Ordnance surveys and private measurements the acreage of England is increasing, but my critic declares nevertheless that the Earth is contracting! According to the recent measurement of the Earth's distance from the Sun it is very nearly a million of miles more distant than the estimate of Newcomb, deduced from observations by six methods; it is more than a million of miles more distant than Leverrier's estimate from the planetary disturbances; and it is no less than 1,800,000 miles more distant than was shown by the transit observations of Stone in 1769. And yet my critic insists that, instead of the Earth receding from the Sun, it is moving in the reverse direction!

I have no idea of escaping criticism. It is exceedingly undesirable that new interpretations of Nature should be too readily accepted; but if, in its publication, I have "only succeeded in producing an absurd and extravagant work," it should be easy to demonstrate such conclusion. It is described as "odd" and "argumentative." I do not know that either of these qualities is necessarily objectionable, although I admit that originality is a fault if unaccompanied by a reference to facts or unsupported by reason. To be argumentative I have hitherto believed to be at least plausibly in the right, and certainly the reverse of "absurd and extravagant." Why did not my critic, instead of appealing to his own imagination for a description of my book, give a true account of its contents? He might at least have shown what, in an argumentative way (as he confesses), the book professes to teach. Must I conclude he was afraid that a mere summary of its contents might go far to satisfy his readers that there was at least something in it worthy of their investigation, and which could not be got rid of by a supercilious assertion as to its absurdity?

If the effect of having received a "really scientific training" would simply have been to have bound me down to the existing modes of scientific thought, I should probably not have disturbed the mind of my critic in the way that I have done. I should have been content to have taken my place in the rank and file of modern science, conscious that there are many persons better qualified than myself to take the part of schoolmaster. But Science has not been created, however much it may have been extended, by a system of schooling.

The introductory chapter of my book explains how, so far

back as 1842, I found myself constrained to conclude that, if we once admit the power of circumstances to effect any change, however small, in animal forms, its efficiency to produce further change must be governed by the presence or absence of the necessary modifying conditions, *to which alone must be assigned any actual limit.* That circumstances were capable of producing some degree of change had never been disputed by any intelligent person. Distinguished naturalists had contended that the dog never existed in a state of primitive nature, but that it was the result of an intermixture of several species; and others, equally eminent, contended that it was a modification of the wolf, the jackal, or the fox. No one disputed that circumstances might wonderfully modify any particular species, and such modifications were known as varieties, and strikingly exemplified in the many different forms of the dog. I thus reasoned:—"If, as is admitted, circumstances can so change the form and nature of the wolf as to produce a dog, why may circumstances not so operate upon the dog as to produce a further change of like extent? And what reason have we to conclude that the change may not go on indefinitely? Or—to express the idea mathematically—if 1 (the wolf) may, by circumstances, be turned into 2 (the dog), why may not 2 be changed into 3 (some other animal differing as much from the dog as the latter differs from the wolf), 3 into 4, and so on to any extent?"

The modern term for such transmutation of species as thus seems inevitable, if the necessary conditions are present, is "Evolution," and hundreds of volumes have been written, during the past twenty years, in its support; but it appears to me that the words I have quoted fully establish the possibility of unlimited change. In "The Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life," Mr. Charles Darwin enters into an elaborate explanation of a process by which the transmutation of species may have taken place. I have no fault to find with his mode of showing that "natural selection" is an agent capable of producing an infinite amount of change in animal forms. He has been wonderfully successful in establishing the doctrine that animals now existing may have been evolved from simpler forms which lived in the earlier periods of geological history; but nevertheless he hesitates to set up "natural selection" as the all-sufficient origin of species, and a belief in their absolute immutability is really a remnant of the Paganism which discovered spirits, gods, or demons in all the most

striking objects of Nature. I affirm that the evolution of species is part of a great plan of creation in which every form of matter is subservient to the purposes of an ever-present Creator, and I fail to see anything "absurd or extravagant" in a conception which is consistent with the fundamental principles of a religion which has largely influenced the thoughts and actions of wise and good men in past ages. To my mind a view of evolution which reconciles, even though imperfectly, the realities of science with the truths of religion, instead of being an object of scorn and misrepresentation, vastly increases its claims to acceptance.

In the second chapter, on "Mind and Matter," I quote at length the introductory chapter of an "Essay on the Constitution of the Earth," published in 1844, to show that man's comprehension of Nature, instead of being, in any case, absolute or perfect, is only relative or comparative. This idea has been elaborated under the title of the relativity of human knowledge, and is, I believe, accepted by scientists who claim to have received a "really scientific training," and who profess to be the recipients of the most exact knowledge. But I argue that the fact that our understanding is limited affords no reason for concluding that we are totally devoid of understanding, and that this applies alike to spirit and matter—to God and Nature; which conclusion is further elucidated in the third chapter. If the belief in an Over-ruling Providence is the fault of my book, why not expose the weakness of my argument in its support?

The next five chapters of my book deal with the laws of God in creation, by which existing things have been developed from those which prevailed in the past. By a law of creation I mean the order, harmony, and consistency observable in the processes by which the changes in Nature have been produced. As already suggested, these changes are governed by the presence or absence of the necessary modifying conditions. Mr. Darwin's theory of the origin of species by means of natural selection admittedly depends upon the selection of *progressive* variations. "Nothing," he says, "can be effected unless favourable variations occur;" that is, favourable to the development of new species. Natural selection, he observes, acts exclusively "by the preservation and accumulation of variations which are beneficial under the organic and inorganic conditions of life to which each creature is at each successive period exposed." Hence Mr. Darwin consigns the origin of species, from natural selection, to the conditions or circumstances favourable to

progressive change or development. The creation of species, he in effect argues, is not the result of natural selection, but of conditions which promote a change (progressive or otherwise?) so great as to represent a new species. This is my conclusion:—I suggest that *the progressive development of species could only arise in connection with a corresponding development of the Earth itself;* and I have propounded what I conceive to be the laws which govern not only the creation of species, but every form of matter; which laws are given at length in my book, and, briefly, in an article which appeared in the "Journal of Science" for August last.

The ire of my critic seems to have been especially roused by the ninth chapter, which suggests that the Earth has derived its existence from the Sun by processes still in operation, and by the astronomical evidence in its support which is given in the next chapter. He appears to have a vested interest in the theory that the Earth and all that is upon it are destined only to afford fuel to keep up for a little time longer the fire that is consuming the Sun. He represents me as affirming that the planets are little orbs "knocked off" from the Sun, and that they are "picking up" their satellites on the way. Such a description might be consistent enough with the mechanical view of Nature which, contrary to the teaching of Newton, sets up gravitation as the god of creation, but it is utterly opposed to the teaching of my book. I show, on the contrary, that plants and animals are constituted with strict reference to the present condition of the Earth. To use the words of the late Dr. Phillips:—"Deprive the atmosphere of its carbonic acid—plants disappear; let phosphate of lime be absent—not only vertebrate animals vanish, but a large part of both the animal and vegetable race would languish and become unproductive." Paley's "Natural Theology" is an elaborate exposition of the relationship which subsists between animal and vegetable existence as now enduring and the Earth's present condition. The constitution of vegetable and animal existence is, in fact, governed by the constitution of the Earth, and it therefore follows that their constitutional changes, as described by geologists, afford evidence of a general corresponding change in the constitution of the Earth. This relationship is entirely inconsistent with the idea of a body falling into the Sun as the result of a blind mechanical force. Attraction describes a relationship, but not a reason of relationship; it expresses a motion, but not a reason of motion. If it be asserted that the Earth is advancing towards the Sun because it is attracted by it, it may be replied that it is

receding from the Sun because it is repulsed by it. If it be asserted that the Earth is attracted by the Sun because it is not further from it, it may be replied that it is repulsed by the Sun because it is not nearer to it. I assert that the attraction or repulsion is the result of a constitutional relationship consequent upon the laws of God in Nature. This relationship has arisen out of the circumstances under which the Earth has been created. The Earth has been constituted under the influence of the Sun, any change in its relationship to which would, proportionately to its importance, change its present condition, just as any change in that condition would effect a change in its entire plant and animal life. Hence I assert that the Earth has derived its existence from the Sun, just as the oak tree has derived its existence from the soil into which the acorn was planted, and by its relationship to which the tree has passed through all the phases which commenced in its first fructification. The Earth's present existence is consequent upon that of the Sun; and as, by the theory of Evolution, its present existence has been derived from the past up to the remotest beginning, its past existence must have been derived from the Sun. I have shown that there is a relation between the sizes of the planets and their distances from the Sun; between the number of satellites of a planet and its distance from the Sun; between the velocity of the revolutionary motion of a planet and its distance from the Sun; and between the rotary motion of a planet and its distance from the Sun; all of which relationships are suggestive of a higher development of the more distant planets. I fail, therefore, to see that there is anything "absurd or extravagant" in the belief that they all originated in the Sun, and that there is a relationship between their ages and their distances from that body. Notwithstanding the proverb, I do not know that growing old is growing cold; I have never heard of the "accepted doctrine" that heat radiates under all conditions; I am certainly not aware that the Earth is growing cold; but some eminent scientists do tell us that there is a constant relationship between heat and motion, and I believe it is a fact that the more distant, and, as I believe, the older planets, have much quicker rotary motions than those which are nearer to the Sun.

In answer to the charge of arrogance which has been brought against them, I have seen it stated that it is certainly not true that men of science, as a body, or the leaders of physical science in particular, have used a tone of overbearing confidence or wanton insult, and I am willing to

endorse the statement. But I am constrained to conclude that my unknown critic is the exception which makes good the rule that "No class of men, however highly instructed, is wholly free from faults of judgment and taste."

II. THE EVOLUTION OF THE SOLAR SYSTEM.

By CHARLES MORRIS.

IN the nebular hypothesis of the formation of the Solar System it is argued that, in an original vast expanse of nebulous matter, centripetal attraction set up rotation of the mass as a whole; that speed of rotation and density of aggregation increased together; that eventually ring after ring of condensed matter separated from the outer edges of the rotating disk; and that, finally, these rings broke up, and their materials aggregated into the planetary masses.

In my article on "The Evolution of the Spheres," in the "Journal of Science" (March, 1881), I have temporarily assented to this view; but a fuller consideration of the subject requires that a somewhat different view be taken. In such a mass of nebulous matter homogeneous diffusion would be simply impossible. Yet if there were heterogeneous diffusion the force of centripetal attraction could not be confined to the centre of the mass, but must also display itself in minor portions of the mass. There would undoubtedly be a general centre of atraction, affecting the mass as a whole; but there would also be minor centres of attraction, affecting certain portions of the heterogeneous mass. Thus, while the nebula as a whole condensed and rotated around its centre, its constituents must also have set up an independent condensation and rotation of their own; the tendency being for the vast mass to separate into many smaller masses, each of which, while yielding to the central attraction, pursued its own independent interior development.

Nor would these minor masses display any similarity in size. In a huge heterogeneous mass of nebulous matter

there must be tracts of partial homogeneity, greatly varying in dimensions; and also dense regions, probably contiguous to rare regions, marking out natural localities of minor aggregation. Thus there is reason to believe that, in the original mass, centres of force of greatly diversified influence displayed themselves, and that the minor aggregations resulting ranged in size from planetary to meteoric dimensions. It is probable, indeed, that this process affected every portion of the mass, the condensing planetary masses being full of minor centres of aggregation of their own, and this possibly extending down to the formation of atomic masses from the heterogeneous aggregate.

But we are here simply concerned with the original independent masses, not with their interior evolution. In respect to the formation of these the centripetal attraction of the whole mass must necessarily possess a vigorous influence. In regions near the centre this influence would be very powerful. The minor aggregations being there formed under the influence of a vigorous central attraction must necessarily be smaller in size, as they could only affect a limited region of the nebula. Their centripetal attraction, at a certain limited distance from their centres, would be overbalanced by the attraction of the general centre, and all substance beyond this distance be swept off towards the solar centre. Of course the size of such minor aggregations must have depended upon the density of the matter from which they were originally composed, and they may thus have greatly varied in dimensions; but they could not have assumed very great dimensions, on account of the overmastering vigour of the central attraction upon their outlying regions.

In the outer portions of the nebula the state of affairs would be markedly different. Here the vigour of central attraction would be greatly reduced, and thus the influence of minor centres might extend to a much greater distance outwardly. Therefore vast regions of the nebula might be brought under the influence of a single minor centre, arising in a partly condensed portion of the mass, before the distance from this centre became so great that its attraction was overbalanced by that of the general centripetal force. Consequently, if the diffusion of the mass made any approach to homogeneity, there must have arisen in it numerous minor masses, increasing in size outwardly with some regularity, and all subordinate in their general motions to the central attraction of the whole mass. This centripetal attraction must remain virtually the same whether the

nebulæ continue in a diffused state, or become aggregated into a sun and attendant planets.

But as it is by no means probable that the original mass approached an equality of diffusion, so it is not probable that any such regular arrangement of the minor masses could result. As a general rule they must have been smaller near the centre of the nebula, and larger in its exterior regions, but beyond this general arrangement their sizes must have been dependent upon the condition of diffusion in the original mass. Every condensed portion of this original mass would tend to set up a local action of aggregation, and the position of the largest secondary aggregate would be governed by the possible existence in the original nebula of some wide field of denser matter, sufficiently removed from the centre to escape the interfering action of the vigorous central energy.

Such seems probable to have been the original process of mass development in the nebula from which the Solar System arose. An allegiance of the mass as a whole to the attractive vigour emanating from its centre; an allegiance of secondary condensed portions of the mass to the attraction of their centres; and a gradual formation of minor aggregates as constituent portions of the great aggregate; these secondary masses increasing in size, but not regularly outwardly from the centre.

These, however, were not the planetary masses we now possess. Nor were they defined rings of condensed matter, or of small masses. They were, more likely, a vast number of small rotating masses, of every imaginable size, and occupying the most irregular positions, circulating around the centre in an immense variety of orbits. If, indeed, we conceive of the original nebula as condensing into a rotating disk, we may conceive of this secondary stage of its evolution as a gathering of its matter into secondary masses, which occupied the whole extent of the original disk. The nebular sun in the centre was thus surrounded by an immense number of planets, of every imaginable size, radius of orbit, and speed of revolution, every radius of the circle around the centre being occupied, at any one moment, by several of these planets. These orbits might be variously elliptical, and out of the plane of the Ecliptic. For the general motion of the masses would have two components of direction, one arising from their allegiance to the central energy, and one from their own condensation—this yielding motion in a direction opposite to that in which the general heat emission took place (as argued at length in the article

above referred to). But it is probable that these masses were not, as a rule, of great dimensions. It seems more likely that a comparatively few great masses would alone exist, their production hindering a like process in the remaining portions of the nebula, on the same principle as that by which the sun hindered them in regions near the centre, through the overbalancing influence of its vigorous attractions. We may thus imagine a vast array of such revolving masses, as a rule of comparatively small dimensions, while among them moved a few much larger masses, irregularly placed as regarded the centre, but with a general tendency to increase of size outwardly. Between these masses the nebular substance must have become greatly rarefied, it being denuded of its material both by the dense masses that moved through it and by the solar attraction, this material condensing towards that attracting body, whether sun or planet, which had the most vigorous influence at each locality.

These secondary masses, however, would not be related to each other as they would to the central mass. In their relations with this there would be a balanced agreement between the speed of revolution and the force of attraction. But in masses moving in nearly parallel orbits around a common centre there would be no such resistance to the effects of their common attractions. Their orbits would tend to approach each other. Every large mass might thus bring a lateral force to bear upon the small mass to a considerable distance on each side. And as scarcely any two of the small planets would have precisely the same orbital speed, they would constantly overtake, or be overtaken by, the larger masses in their annual revolutions, and thus be drawn more and more towards these larger centres of force, through the effect of lateral pull, until eventually aggregation would arise between the parallel moving bodies.

Such huge original aggregates as we may conceive the primary core of Jupiter to have been may have thus swept a vast extent of space of its smaller bodies, and gradually gathered them into its own mass, its attractive energy increasing with every such addition to its matter. Thus the few larger spheres may have grown at the expense of the smaller spheres, swallowing up all these except those moving at their own speed and in a distant part of their own orbits. But these again would be subject to perturbations from the attractions of distant large orbs, and thus brought into positions exposing them to overwhelming lateral attractions.

Of course, in such a process, other conditions than those here considered might arise. In vast regions of the nebula it is possible that no single mass might aggregate sufficiently large for its energy to overpower the resistance of its neighbours. In such a case the minor masses might preserve their individuality, and continue to revolve as separate planets around the centre. But such a condition could arise only under special relations between the Sun and its attendant planets; and these relations exist in one portion of our Solar System, in the region of the asteroids. The huge mass of Jupiter has swept the space beyond these of all its minor planets. But the influence of its perturbing attraction is constantly exerted against the counter influence of the Sun, and at a certain distance inward the solar attraction must have hindered perturbations sufficiently wide to bring the minor planets within the grasp of Jupiter. For a vast space inward from this limit the quantity of matter seems to have been comparatively small. The next inner planet is Mars, one of the smallest of these bodies, and quite incapable of greatly perturbing, or of drawing to itself masses at the distance of the asteroids. In this ring of asteroids, then, and in their great diversity of orbits, we seem to perceive a permanent remnant of a temporary condition of the Solar System, ere the overmastering attraction of the larger masses had denuded the space in their vicinity of all similar minor planets.

It is by no means impossible that cometary masses arose from the same causes. Small bodies, whose orbital revolution was greatly disturbed by the perturbing attraction of the large masses, and which yet succeeded in escaping from this influence, might well have gained very elliptical orbits through these vigorous lateral attractions, and been forced to assume the most diversified directions of revolution around the centre.

The final direction of revolution of the planetary masses would necessarily be the complement of the many motive influences which arose from their mode of aggregation and the various perturbations to which they were subjected, their orbits thus becoming necessarily more or less elliptical, and inclined to the Ecliptic.

Again, as Nature knows no great or small, and as her principles of operation constantly work to the same result in the same general conditions, without reference to the quantity of matter concerned, so we may reasonably look for similar results to arise during the condensation of the planets. These were probably at first gaseous in aggregation,

and heterogeneous in diffusion of their materials. Consequently it seems as if a similar process to that above considered must have displayed itself in the planets, the outer portions of their substance condensing into numerous smaller bodies, and these again gathering, under the influence of their larger individuals, into moons. And in the moons we have an instance significantly like that of the asteroids. For the rings of Saturn seem to present an instance of such an array of smaller revolving masses, too much under the influence of the planetary attraction to be swept away by the outer moons, and with no large mass capable of acting as a minor centre of aggregation of the materials of the rings.

In the astral system, of which our Sun possibly forms part, a similar process of aggregation may have gone on; in which case our Solar System would be but the outcome of one of the secondary aggregations of the general mass, while the vast rarefied space between the spheres of this astral system would answer to the lesser rarefied spaces between our planets. Likewise, as the comets which appertain to our system may have arisen from some of the original small masses, which retained their independence through being forced into very elliptical orbits, so the comets which come from without our system may have arisen in like matter in this intermediate space, and have gained their irregular orbits through the overbalancing attractions of Solar Systems.

If such cometary masses took part in any degree in the formation of planets, they would be a disturbing agent adding to the tendency of irregularity in the planetary motions. Such irregularity, whether arising from this cause or from lack of central influence, must be most declared outwardly, and in our system is most evident in the outermost planets. The moons of these planets are even unconformable in their motions to the direction of the solar influence, but not to that of their immediate attracting centre, to which they are simply eccentric.*

Another question of importance in this connection concerns the evolutionary processes in the planets, subsequent to their condensation into solidified masses. It is generally taken for granted that suns and planets now contain their

* It is very probable, also, that in the condensation of a heterogeneous nebula the centre of gravity would not be the centre of volume. If so, the mass as a whole would describe an elliptical movement, while its minor components might assume variously elliptical orbits, from their special individual relations to this centre of attraction.

utmost quantity of matter, except as they may be added to by meteoric accretion. One hypothesis argues that the Earth, and presumably all planets, will eventually absorb all its seas and atmosphere, and afterwards roll on through space, a dead world. Yet it is possible that these conclusions have been too hastily reached.

It was formerly argued that the atmosphere, from its rate of decrease of density, must cease to exist at a height of some fifty miles from the surface. Yet we now know that it is sufficiently dense to produce incandescence, through friction with meteoric bodies, at a height of several hundred miles, and may extend to a much greater height in a more diffused state. Thus we have some reason to believe that it has no real limit, but shades off imperceptibly into the matter of space, this matter being condensed around every orb, and gradually rarefied outwardly.

It might be supposed, however, that we could imagine a true limit to the atmosphere at that point where it ceases to be sufficiently controlled by the earth's atmosphere to be obliged to rotate with it. But we hope to show that there is no such limiting point, and that the atmosphere in this respect also shades off into the inter-spheral conditions of substance. The earth is a globe of matter limited in size by two diverse forces—the centripetal force of gravity, and the centrifugal force of rotation. Its gravitative vigour depends upon its material contents and their degree of condensation. To this vigour the atmosphere adds very little. The density of the material possessed by the earth is not a direct consequent of gravitative force. It arises partly from a secondary effect, that of local aggregation from the gaseous into the liquid and solid forms. Through this local action the condensation of matter became much greater, and thus its immediate gravitative effect was greatly enhanced. This has, of course, much increased the density of the atmosphere, and every such increase in the density and decrease of size in the solid mass must add to the atmospheric density, by bringing the gaseous substance nearer to the centre of gravity, and increasing the gravitative pressure upon it. But if we pass outward into space, to the point to which the material now composing the earth and its atmosphere extended in its nebulous condition, we will find that any substance beyond this point is entirely unaffected by the earth's condensation and solidification. The effect upon this outer sphere of matter depends only on the quantity of material within it, and it matters not whether that material be in a state of gaseous diffusion or of solid condensation.

But if the effect of condensation has been to add any new matter to that originally possessed by the nebulous earth, then the influence upon outer substance must have increased. And there is no reason to doubt that such new matter has been added. For as the nebulous mass condensed into its solid state it would, of course, denude a vast extent of space of its material contents, thus tending to produce an abnormal vacuum unless exterior matter pressed, both through its power of diffusion and as a result of terrestrial attraction, into this denuded space. It is very probable, then, that the condensation of the earth has added to the quantity of substance within its range of influence, and that any solidification of its existing atmosphere would tend to produce a new and denser atmosphere, through the influence of increased gravitative energy.

But now we may again ask, what portion of this gaseous envelope of the earth really belongs to it as atmosphere? There are two forces involved in considering this question—that of gravitation, and that of centrifugal energy of rotation. Gravitation in itself does not cause the matter upon which it acts to rotate. Rotation is a secondary effect, whose cause we need not consider here. But we can safely say that this cause weakens as we reach a considerable distance outward from the centre, and that much of the rotation which exists comes from a tertiary cause, that of friction. But this, again, is an influence which weakens outwardly, through the growing rarity of matter. The particles composing the solid crust of the earth are forced to rotate in unison, through their mutual friction. It is the same with the particles composing the lower atmosphere. But as we ascend into the region of the rarer atmosphere this frictional effect rapidly decreases. It decreases, in fact, just where it should increase, if the necessary result is to be produced. For as we leave the centre the rapidity of rotation must increase, through the increased length of orbit of the particles. Necessarily, then, as both the forces that produce rotation decrease in this rare outer atmosphere, the rotation itself must lag. The spheres of outer atmosphere must fall behind those of the inner atmosphere through the rapid diminution of the frictional influence. Instead, then, of the earth possessing an atmosphere which revolves in unison with it to a certain point outwards, and then suddenly ceases to revolve, it is far more probable that its atmosphere begins to lose its rotating energy as soon as its denser regions are passed, and that it rotates less and less rapidly with the continual decrease in frictional influence, until all rotation

ceases, and it becomes continuous in condition with the matter of space. At this undefined point we reach the true atmospheric limit, or the outermost point of direct allegiance of outer matter to the earth. This limit perhaps constantly varies. At every approach of a planet the gravitative influence of the earth is partly neutralised, the density of the atmosphere decreased, and its frictional power reduced. The influence of the sun and moon must produce still more marked results; and the atmospheric perturbations and storms are, no doubt, very largely due to these exterior influences upon its density.

If the earth were at rest in space the result of the above action would be to give the atmosphere a shape markedly different from that of the solid earth. For as we pass from the Equator towards the Poles the rotatory vigour decreases, and becomes null at the immediate poles. Consequently atmospheric friction might be more effective in producing the decreased centrifugal motion required, and the true atmosphere would assume the shape of an elongated spindle, its axis extending in the line of the poles.

But the earth is not at rest in space. It is moving through space at a very rapid speed. Thus the friction of its atmosphere is not alone concerned in producing rotation in surrounding matter, but also in carrying this matter forward with the earth in its flight through space, as a permanent envelope. Here, too, there is a resistance of outer matter to this influence, and a disposition to lag. Probably to a certain distance outward the combined gravitative and frictional vigour of the earth carries this atmospheric matter forward at its full speed. Beyond this distance these influences so weaken that the matter of space lags behind in the race. This lagging increases until, at a certain limit of distance, the atmospheric matter quite ceases to accompany the earth in its orbital flight. Here is another atmospheric limit, shading off and imperceptibly disappearing like the former. Its shape, however, should be spherical, since its producing influence would be equal in all directions from the centre.

As remarked above, the effect of absorption of the existing atmosphere into the earth's crust would necessarily be to increase the earth's gravity, and thus to attract new matter into this denuded space. But another consideration arises here. Our atmosphere, in its lower portions at least, is not composed of disintegrated matter, but of chemical atoms and molecules, matter in a state of partial condensation. It is not at all probable that the matter of space exists in

this integrant condition. It is, doubtless, largely or wholly disintegrated. As to the matter composing our atmosphere, we are ignorant of its condition beyond a very limited height. Near the surface it is composed of oxygen and nitrogen, with small quantities of some chemical compounds. At a comparatively small distance from the surface these chemical compounds may cease to exist. But it is quite possible that here the oxygen and nitrogen are accompanied by a third elementary constituent, namely, hydrogen. For in the excessive rarity and active molecular motion of the atmosphere at this level, hydrogen may be insusceptible to the attraction of oxygen. Though the apparent temperature may be low, the absolute temperature is high in all such rare gases, from their greatly increased heat capacity. Thus, at a certain lower limit of rarity, oxygen and hydrogen may be so related in their vigour of molecular movement as to yield to their mutual attractions, and combine into water vapour; while beyond this limit their absolute temperature may be too high to permit of such combination, and they will remain separate. At a still higher level it is probable that oxygen and nitrogen may cease to exist, as such, and become separated into their simpler constituents; while hydrogen, from its lighter character, may remain intact to a much greater altitude. Yet it, too, must eventually separate into its constituents, if it is really molecular in condition. Finally, the rarification may become so extreme, and the absolute temperature so great, that the matter concerned in our atmospheres may separate into its primary atoms, or possibly into its ethereal or completely disintegrated state.

The density of atmospheres, therefore, depends not simply on the condensing effect of spheres upon the matter of space. For this condensing influence, by reducing the distance between particles and lowering their temperature resistance, renders possible local aggregation into atoms and molecules, and thus yields a special density which greatly increases the susceptibility to gravity. Therefore the density of the atmosphere of any planet depends only partly on its gravitative energy, and partly on the secondary condensation which takes place when the atmosphere becomes sufficiently dense to permit of chemical integration.

Thus a small sphere might be destitute of any but a very rare atmosphere, from its not being able to produce the density necessary to set up this secondary action. Such may be the case with our moon. Its atmosphere may consist only of the primary integrations of the matter of space, in a state too diffuse to become apparent to us. Here there

is a marked distinction between the state of condensation of the solid and gaseous surfaces. As globes increase in gravitative vigour this distinction decreases. It is much less declared in the earth than in the moon. In Jupiter, or in the Sun, it may be so reduced that no real distinction continues to exist. The atmosphere of the sun may be, or may become, so dense through gravity and pressure, and through chemical integration, that in this orb the three states of matter—the solid, the liquid, and the gas—may eventually shade into each other with no marked line of demarcation.

If, again, the earth cannot absorb its atmosphere, and remain denuded of an atmospheric covering, neither is it probable that it can dispose finally of its liquid covering. For the absorption of the water surrounding the earth must act to decrease the density of the atmosphere, by depriving it of its aqueous vapour. In such a case the tendency of the remaining atmosphere to greater condensation might bring the possible hydrogen which exists in contiguity with oxygen above their combining level to a lower level, and produce a new production of atmospheric water vapour. It is certainly conceivable that any loss of water at the surface might be thus compensated, and even that such a production of water vapour may occasionally occur now; balanced, perhaps, by a reverse action, as now hydrogen descends below the limiting level, now water vapour ascends above it.

In fact, the process of formation of the solid surface of the earth may have been through successive stages of development similar to that above described. As density increased the atmosphere partly became liquefied. Further condensation solidified this liquid, and a new liquid replaced it. The solids became more and more complex and dense, while successively new liquids appeared. Finally only the most volatile elements remained in the atmosphere, and these, in their turn, partly condensed into the liquid called water. This is also, by the slow process of refrigeration, approaching its solidifying point, and would long since have passed it but for the external heating influence of the sun. This liquid is also being slowly exhausted through absorption into the solid surface; but as it is composed of two of the lightest elements, which are likely long to continue abundant in a gaseous state, all such loss by absorption will probably be replaced by new production. We have water on the surface, water vapour in the atmosphere extending to a certain height, and beyond that height free hydrogen. Thus hydrogen as well as oxygen may extend through all levels, but

may be prevented from descending to a level which would bring it within the grasp of oxygen by some influence from the presence of water vapour, it descending only when the atmosphere is greatly denuded of its water vapour.

If now refrigeration of the earth's surface should become sufficient to solidify all its liquid water, or to convert all existing and all new-formed water vapour into snow and ice, what would result? Certainly an increasing gravitative vigour, and an atmospheric denudation which must be replaced by some form of new condensation. It is not inconceivable that, if the present atmospheric constituents were measurably exhausted, they might be replaced by other elements capable of yielding new cycles of terrestrial evolution. Yet if we are to judge by the apparent conditions of other spheres, it may be possible that hydrogen is the lightest available chemical element, and that a waterless sphere would be a dead world.

III. THE FORMATIVE POWER IN NATURE.

By Sidney Billing.

A CORRESPONDENT (H. B.) in your issue of April comments on the article "The Formative Power in Nature," written by me, and which appeared in the February number of your Journal, of which, I suppose, generally he approves, although "the arguments and illustrations are not new ones." I did not pretend to novelty in idea, or to originality; my intention was merely to bring together such facts as I deemed to be incontrovertible, and I endeavoured so to marshal them that they should present that outcome which common reasoning would assign to them,—with what success I leave to the judgment of your readers.

The subject in comment is large and varied, and may be considered as the vexed question of the day; it is only important because casual readers and half-thinking men are caught by the glitter of words, and are thus led away from the significance of the proposition, accepting too frequently

the theories advanced as the real outcomes and the matured conclusions of Science, when generally they are the baldest hypotheses. New theories crowd upon us; but when we find it advanced as a serious conclusion that every particle of matter in the universe is self-conscious, thinking, and sensitive, we are much inclined to use the talk of the showman, and enquire "What comes next, Mr. Merryman?"

As a general principle it is not my wont to indulge in new theories, or strive for originality; my effort generally is to state my proposition in plain words, addressing myself to the common sense of my readers rather than to the endeavour to excite their wonderment. New theories, too usually, present the very bathos of absurdity. One theory, now old, which at the present time is the very basis of Kosmic ideas, however extreme it may be in idea, meets with a general acceptance. The conflagration theory, with flaming hydrogen and nitrogen,—a world of combustion!—although based on the nebular theory of the great Kant and confirmed by the mathematical precision of the equally great Laplace, or rather I should say contemporaneously thought out by these great minds, and by the latter produced as a mathematical formula, is to my mind untrue and unscientific. The absurdity of such a Kosmic scheme is well illustrated by a very celebrated popular scientific lecturer: he accepts the scheme, and there was *no irony* in his idea when he wrote "Not alone the mechanism of the human body, but that of the human mind itself,—emotion, intellect, and will, and all their phenomena,—were once latent in a fiery cloud." To suppose the possibility of intellect being but an emanation from "a fiery cloud," even though the conflagration were general, seriously proposed, the assumption in itself is a *reductio ad absurdum*.* We know that all substances can be resolved into gases, but we do not perceive them as subsisting flaming elements. Another peculiar hypothesis, that of another distinguished physicist, is that life was introduced upon the earth by an atom from an exploded world. The wonder is not that such an hypothesis was conceived, but that it is said to be accepted by Prof. Helmholtz, a clear and acute reasoner: surely he would at the least have seen, supposing it were so, that the origin of life is not thereby accounted for; come from what or whence it may, its antecedent must have been a living intelligent energy. Great philosophers and great workers frequently, when they stray without the pale of their specialities, indulge in eccentricities

* *Vide*, for the author's Kosmic idea, pp. 19 to 24 "Scientific Materialism," &c.

—the idiosyncracy of great minds. Had H. B. carefully noted what I wrote, he would have seen that I did not suppose I was adducing anything new. I wrote "I am merely testing, &c., ... by the commonest phase of surface reasoning."

"The material philosopher counts his atoms, and decides the Kosmos is composed of units of matter, in its eternity combining cause and effect." "The physicist considers his conceptions as a summation of effects, and as an idealisation of his dream finds the bases of all things in eternal matter." The natural philosopher, in a purer ideal, "taking note of infinitesimal quantities, brushes them aside in the truer aim of disclosing the religion of Nature, wherein he finds an intelligence which man alone, of all created beings, shares." Nature, whether contemplated in her higher or lower phases, has the same cadence, harmony, symmetry, and sympathy, whether exemplified in a sand-grain or a world, and in the beyond, a providence exemplified in the laws of being, not supernatural, although supersensual.

H. B. thinks "I should have demanded the meaning of the word spontaneity," &c. There was no occasion to enquire what Prof. Haeckel meant by spontaneity; he explains it (this I should have thought H. B. would have known—he quotes as though he had read the work). Spontaneity pure and simple is *generatio æquivoca*, *i.e.*, the coming into being through a self-imposed and inherent necessity, without the action of any will, as Topsy came into being, *i.e.*, she "growed;" in fact exactly as Webster defines the word as derived from the Latin *spontaneitas*, "the quality or state of being spontaneous, or acting from native feeling, proneness, or temperament, without constraint or external force, *i.e.*, from an inherent necessity." Spontaneous has quite a different meaning: Lat. *spontaneus*, from *sponte*, free will, voluntarily. That I understand by spontaneous or spontaneity I have written elsewhere.* It is sufficient to say I do not mean *generatio æquivoca*. There exists no need "to hoist them (the monists) with their own petard;" they are always being "hoisted," but they always return to the charge, frequently with increased virulence. If the principles of our common reason have no effect, hard words are sure to fail.

Referring to a paragraph in which I say "Stratifications could only have arisen from a solidification of the gaseous substance which in amalgamation we term the ether," instead of stratification I should have said solid substance

* Scientific Materialism, &c., pp. 235 to 261.

(which was in my mind at the time I wrote). Stratifications arise, as a general principle, from the denudation of the rocks, sometimes modified by igneous action. H. B. says "he is uncertain whether he understands the author's meaning," and goes on to say "presuming" (as the printer makes him say) "that it is the lumi in germs," instead of, as it should have been, "the luminiferous ether" that is here alluded to, which he seems to consider as a gas more subtle than those composing our atmosphere. I would observe that this theory is a mere assumption," &c. He answers this phantom assumption which he has reared by another theory which is equally an assumption. *Passim* I may say the concluding paragraph of H. B.'s letter (on p. 243) is a complete mystification: whatever be his conception of the Creator or Creation, he should at the least have supposed that an act of creation was done once for all, not to be afterwards modified and adapted by *Him*. Whatever creation was, to my mind, the act was done once for all, self-containing and self-continuing; being stored with interior energy it became self-modifying. A tentative power, so far as the Creator is concerned, could never be conceived by anyone who has a true and real appreciation of what the Creator as God must mean, "who said be, and it was." These confusions arise, no doubt, from the attempt to reconcile in his mind Theology with Science.

It is not because to our perceptions there are different forms of matter (*i.e.*, elemental substances), that they were created in the forms which are presented to our perceptions. It is more than possible that they are the modifications and differentiations of one primordial substance by the interfusion of the forces (unless force and matter had one and the same initiation). The chemical properties of carbon and its extraordinary combinations (so to speak) lead to this inference, and this view gathers pertinence from the fact that Mr. Norman Lockyer resolved one of these so-called elements (if I mistake not, copper), proving it to be a combination.

Mr. Crookes has shown that there is a fourth state of matter, and probably a something beyond; therefore it would be easy to arrive at the idea "of a gas more subtle than that composing our atmosphere." If I were asked what my idea of the ether is, I should probably answer—a subtle something which permeates the universe, and proceeds directly from the will of the Creator, in which all things exist, and out of which worlds and systems of worlds, and all things which exist with them, are formed.

The luminiferous ether by substitution for the "lumi in germs" still leaves me at a loss; it is a phrase frequently met with, but what does it mean? If presented as the source of light (it neither bears nor produces) it is meaningless. The ether permeates all things; hence, if "*luminiferous*," there were no possibility of darkness—no night. All conceptions as to what the ether is must be purely conjectural. Balloonists assert that the higher they ascend the atmosphere the darker and colder it becomes; yet they have not probed it by more than one-tenth vertically. There is no vacuum. Were the ether the source of light or light giving, the higher the ascent the brighter the aspect. The sun is the source of light, but this light does not arise from the *heat* of the sun: were it so, the higher the ascent the warmer the atmosphere should be. Coldness and darkness are not very consistent with a *luminiferous* ether, nor with a *heat-emitting* sun.

The phrase luminiferous ether has grown into vogue because it has the seeming of science, and has been used by some scientific orator who delighted in words having more sound than significance, and hence adopted by others in the presumption of value; but whatever that be it is purely suppositious. It is doubtful whether the man who first connected luminiferous with the ether knew its meaning. There can be no question but that the sun is the source of both light and heat, so far as his system is concerned, by transmutation (*correlation*); as well it might be said that the agglomerated substances which coalesce to make the protoplasm are the *sources* of life, as to talk of the luminiferous ether as the *source of light*.

H. B. *surmises* the absence of gravity, as in connection with the ether, prevents its solidification. If it be not from the ether, from whence are derived the substances we know as matter, solid or gaseous? Some German philosophers appear to treat gravity and gravitation as distinct properties; the first referring to terrestrial substances and things connected with the earth; the latter in relation of sun with sun thus permeating the universe.

We know not what the ether is, whether a creation or what; but whatever it be, it is no doubt the nucleus—or I may say the seething-vat—from whence Nature draws her resources, and out of which all we know as terrestrial formations arose by condensations, coagulations, and *force* impulsions.

I do not think the system a good one which needlessly intrudes the idea of the Creator in a theological sense, or to

speak in a scientific article of what "Christians worship and adore." All men, willingly or unwillingly, entertain the idea of God, and all thinking men attempt to define him, because all such men desire to understand that which is the object of their faith. So far as I can understand or learn (my studies have been somewhat extensive) no man has yet accomplished that object. Dean Stanley says, "To Spinoza was vouchsafed the clearest glimpse into the nature of Deity." After a contemplation of this most momentous conception, man falls back on the comparative nothingness of himself, and finds how miserably small is the faculty he possesses when he endeavours to grasp this stupendous idea. No man by his reason can define what God is, nor where God is; no human reason can teach of his being or of his existence. We go to Nature, and there find order amid diversity, and homogeneity in seeming heterogeneity. We know that accumulated accidents do not constitute order: where order is there is always intelligent direction and superintendence; hence we infer that Nature had an ordinator, and that all we perceive must have been the result of that ordinator's will, combined with a maintaining power which may well be termed a providence. We see the machine, and infer that there is a machinist or creator. We see intelligent direction, and therefore infer that there is intelligence in the machinist. We see the exemplification of power, and we therefore infer that the machinist is powerful. We see an orderly maintenance and direction, and therefore infer the continual presence of the machinist. The corollary of this exposition is that the machinist is all intelligent, because all his works which we are able to examine are perfectly adapted to their particular placements, and of each to the other; that he is ultra-powerful, because the great and little —the floating mote which reflects the magnetic action of the sun, comprehended as light, and worlds and systems of worlds—are in his grasp; that he is ever superintending, because the universe is orderly administered,—*i.e.*, the universe is order. Thus we arrive at a Machinist or Creator who is omniscient, omnipotent, and omnipresent; further than this no reasoning will lead us.

In the Vedic poems of Chaos, or the beginning, we read: —"Nothing that is was then, even what is not did not exist then; what was it that hid or covered the existing? What was the refuge of what? Was water the deep abyss, the Chaos which swallowed up everything? There was no death, nothing immortal. There was no space, no life, and, lastly, no time, no solar torch by which morning might be

told from evening. That one breathed breathless by itself; other than it, nothing has since been. That one breathed and lived; it enjoyed more than mere existence; yet its life was not dependent on itself, as our life depends on the air we breathe. It breathed breathless. Darkness there was, and all at first was veiled in gloom profound as the ocean."*

The Chinese philosopher, Lao-tse, says—"Tào, if it can be named, is not the eternal one. The nameless one is the foundation of heaven and earth. He who has a name is the mother of all things. He who begins to create has a name." He further describes the unfathomable Tào:—"It strives not, yet is able to overcome. It speaks not, yet is able to obtain an answer. It summonses not, yet men come to it of their own accord. It is long suffering, yet is able to succeed in its designs."

These are the philosophies of India and China. What more do we know of the Infinite Supreme? Were this all we should have the cognition of Deity, but no realisation. Happily we have within us, by the ordination of the Creator, an invisible chain which connects the spiritual in man with that grand and eternal supremacy which creates, guides, directs, and maintains. We "have besides Reason two other organs of knowledge, Sense and Faith, neither subordinate to the other, but co-equal. Faith is that organ of knowledge by which we apprehend infinitude. The Infinite hidden from the senses, denied by reason, is conceived by faith underlying the experience of the senses and the combinations of reason."†

All that we can conceive of Deity is consolidated in faith, that inner action of the mind which compels to reverence and duty, but which in abuse becomes superstition and intolerance. Man cannot escape a faith; "it is a conviction implanted in the human mind of something ineffable."‡ Lord Amberley says "Religion formulated in intelligence postulates its position as fixed and final. It no sooner appears than a formula is instituted against which it is continually protesting. The attempt is always made to confine it within a set of dogmas. Sooner or later the religious sentiment bursts from the imposed thrall, but awaiting the new advent is another scheme of dogmas. This is the history of creeds in all ages of the world, and it is not the less true that the deepest hostility to theological systems is inspired

* Hist. Sanskrit, litt. MAX MULLER.
† Science of Languages, MAX MULLER.
‡ JUSTIN MARTYR.

by the very sentiment to which those systems seek to give a formula and definite expression.*

I have been led into a digression because I saw that, if H. B. did not understand a plain statement, others probably might fall into the same error. Theology and Science are exactly opposite in their nature, their only analogy being the dogmatic assumption of their professors. Whilst religion knows no creeds; it is universal in its application—the parent of faith and moral duty. It induces contemplation whereby man can discern that God unknown to our reason, is verified by faith, and in the wondrous formations of Nature reads as in a book penned by the fingers of a Supreme Intelligence. Thus Nature, in the unison of her harmony, is enthroned in divinity of which the universe is the embodiment, finding a reality in the illimitable all, that which was and that which is, the sole Eternity—Intelligence which rules all things, perfects all things, and exists in all things, personified becomes that we know as God.

I do not know what importance H. B. attaches to his concluding sentence when he talks of "the original fundamental form of matter." If he would tell the scientific world what is force and what is matter, he would do more service than by reading an article and interposing his own assumptions as the author's conclusions. Elsewhere I have very fully given my ideas as to force, matter, and the economy of Nature. In an article of limited space it is impossible to state the grounds for the conclusions, and I do think it wiser for persons thoroughly to understand an author's meaning before they introduce their own assumptions as explanatory of a text which they misapprehend.

PS. It were more courteous, when a comment is made on an article signed by the author in full, if the commentator signed his name in full. In future I shall take no notice of comments on articles signed by my full name, unless the commentator does the same.

* Analyses of Rel. Belief. The above is the sense, but not the exact words.

IV. HUMAN COMPLEXION AND ITS CAUSES.

THE varying colour and texture of the human skin have long been a vexed question among anthropologists and ethnologists, and the common explanation, which ascribes all these differences to latitude, breaks down on the most moderate scrutiny. It is easy to say that the Negro is black because he lives on the Equator, and that the Moor, the Spaniard, the Frenchman, the Englishman, and the Norwegian are progressively fairer of complexion as their dwelling-places approach the Polar regions. But if we look to the western side of the Atlantic we find no such series of changes. The aborigines of America, whether in arctic, temperate, or tropical regions, vary little in colour, and it may safely be said that under the Equator, in Brazil, they are not the darkest. Even in the Old World we meet with facts quite inconsistent with the "latitude" theory. The Swede and Norwegian are very light-coloured, but to the north of them live the swarthy Lapps and Greenlanders. The Maori, living in a climate not unlike that of Britain, is as dark as the natives of Tahiti or Hawaii within the tropics. In Europe we might even be led to suppose that colour was a question of longitude. If we travel from France eastwards, we find in Germany a decidedly lighter complexion prevailing. But if we continue our journey eastwards we find dark hair and eyes, and even a dark tone of complexion, among the Bohemians and Poles. If we enter Asia we find the yellow Mongol race varying little in tint from the South of China, and even from Anam to the frontiers of Russia. These instances, which are given merely as specimens selected out of a great number, are surely more than enough to show that human complexion is not a function of latitude.

Another theory is that the inhabitants of mountainous regions are fairer than those who inhabit the plains, the latitude in each case being the same. We see scant foundation for this view. The Norwegian mountaineer is no darker than his neighbour the Swede, and both of them are, if anything, fairer than the Russian, the native of one of the flattest countries in the world. In the British Islands dark eyes, hair, and complexions are quite as common in the mountains of Wales and Scotland as in the most level parts

of England. The inhabitants of the Mexican table-land are as brown as those of the *tierras calientes*. "The Aymaras and Quichuas of the Peruvian Andes are darker than the Yuracaras of the forests to the eastwards.

A further supposition is that the more carnivorous races of mankind are fairer than their vegetarian neighbours. In opposition it may be urged that the Red-skins of North America, who subsist almost entirely upon the produce of the chase, are darker than the European immigrants who have almost entirely displaced them.

All these attempts at an explanation of the facts of complexion being therefore quite unsatisfactory, there is need and room for a new theory. Such a one has been propounded by Mr. J. M. Buchan, M.A., in a paper read at a meeting of the Canadian Institute of Toronto,* and is decidedly worthy of a careful examination. The author recognises two factors, well known to have a great influence upon animal and vegetable life, temperature and climate. He arranges climates under five heads:—

I. Arctic.
II. Temperate moist.
III. Temperate dry.
IV. Tropical moist.
V. Tropical dry.

Before proceeding to examine the kind of skin best adapted to these different climates, he gives a brief account of the epidermis and of its colouring-matters. Here he takes occasion to remark that "the deeper the shade of the pigment the more rays will it reflect, and the more effective will it be as a protective agency. On the contrary, the lighter the shade the more light and heat will it permit to enter the body."

Now except the pigment of the skin possesses properties totally different from all those with which physicists have been in the habit of experimenting, this is a most perplexing statement. We find, by direct trials, that the darker any surface the more readily it absorbs radiant heat. Water placed in a tin vessel coated with lamp-black will rise to a higher temperature on exposure to the sun than if placed in a similar vessel painted white. And, in virtue of the very same principle, water in a black can, if left in the open air on a frosty night, will freeze more rapidly than if it had been

* *See* Popular Science Monthly, May, 1880.

put in a white can. Just the same is the case with light. We call a surface white when it reflects all the incident rays, and black when it absorbs them all. We are not aware that the difficulty has ever been fairly met—why a colour should be advantageous for the skin in a hot climate, when for everything else which we wish to preserve from overheating it is found disadvantageous.

To proceed: Mr. Buchan contends that in an arctic climate transudation is accelerated. "The frosty air, raised in temperature many degrees by contact with the body, becomes very dry, and greedily drinks up its moisture." Thus the temperature of the system is lowered, and at the same time the person suffers from excessive thirst. Hence a very thick skin will be needful, which, though containing little pigment, will produce a swarthy effect.

By a "moist temperate" climate the author means one like that of Western Europe, where the range of temperature is small and the air contains a large amount of water in solution. Here perspiration is reduced by the inability of the atmosphere to take up much moisture. The cuticle is constantly thin, and the complexion clear and fair. In "dry temperate climates" the air is usually dry, the summers hot, and the winters severe. Hence a thick cuticle is needed "to prevent the too rapid withdrawal of the fluid contents of the capillaries by the dry air," whilst the presence of a pigment "suitable to the intensity of the sun's rays" produces various shades of yellow and brown.

Under a "humid tropical climate" the author ranks such as have no dry season, with a high but steady temperature. The power of the sun's rays will be so diminished by the abundance of vapour that the inhabitants will not require the protection of so dark a pigment as the natives of other tropical regions. A thin epidermis will be needed to facilitate perspiration. Hence the natives of these equatorial regions should be distinguished by relatively fair complexions. In such tropical climates as are rainless, or possess well-marked dry seasons, the rays of the sun will descend with full power, whilst at the same time a considerable degree of cold will be experienced before sunrise. To meet both these extremes a thick outer skin will be required, and we therefore find in such regions the blackest men and the thickest skins.

A great part of the author's contention must be at once conceded. In dry climates, whether cold or hot, and in such as undergo great vicissitudes of temperature, a thicker skin is undoubtedly required than in regions where the air

is humid and the range of the thermometer small. This law is plainly stamped on the vegetable world. But when we come to the consideration of colour we meet with difficulties which cannot be overlooked. Let us take, in the first place, the moist tropical climates, the regions situate on or near the Equator, including, of course, the Valley of the Amazon, a certain portion of the African continent, Sumatra, Borneo, and New Guinea. Here, according to Mr. Buchan, the natives should have a thin cuticle and a relatively fair complexion; yet in this equatorial zone we find a very considerable diversity. We have the copper-coloured native of South America, and the black negro of Congo and the Guinea Coast. Now the aborigines of equatorial Brazil, as we are told by so experienced an observer as Mr. Bates, bear their native climate not merely worse than the blacker and thicker-skinned negro, but even worse than the European! Again, we should think, on Mr. Buchan's theory, that, *e.g.*, an Englishman, with his thin cuticle and light complexion, ought to bear the climate of the Gold Coast better than the dry tropical or semi-tropical regions of Australia,—which is very far from being the case. The author remarks that "there are blacker men in New Guinea than in Borneo and Sumatra." Now all these islands lie in the humid tropical region. According to Mr. A. R. Wallace the climates of Borneo and of New Guinea are exceedingly similar, warm, constant, and humid. Why then should the natives of New Guinea be blacker than those of Borneo? Why do the latter differ in complexion from those of the Gold Coast, or of equatorial Brazil?

As regards the moist temperate regions there is one very significant fact mentioned in Mr. Buchan's favour. The north-western coasts of North America, including British Columbia and Alaska, approach north-western Europe in their meteorological character. The air is humid, the temperature constant and—for the latitude—high. The annual mean heat of Sitka is higher by 2 degrees than that of Quebec, which lies more than 10 degrees farther to the south. Here, accordingly, the aborigines have complexions not very different from those prevalent in Southern Europe. Fair hair, ruddy cheeks, and light eyes are not uncommon. But if we consider the climates of Tasmania and New Zealand, not very unlike those of Western Europe, and certainly mild, moist, and fluctuating little, we find a discrepancy which the theory does not explain. According to the most trustworthy accounts the aborigines of Tasmania, now extinct, were as dark as, if not darker than, those of the

mainland of Australia, which belongs to the dry temperate and dry tropical regions.

In the Polynesian Islands we find black and light brown races living in climates which differ respectively very little, if at all.

The dry tropical regions afford further difficulties. Torrid and sub-torrid Africa, outside the equatorial belt, presents a black population; whilst that of tropical China, Annam, &c., is yellow, and that of Mexico and Southern Brazil and Bolivia brown. Why these differences in regions all hot and dry?

Many of these difficulties may doubtless be solved by taking into account the migrations that have taken place. A race may have changed its seat, and not yet have assumed the complexion most in harmony with its surroundings. Thus the aborigines of South America may, as Mr. Bates supposes, have arrived from a colder country, and, unless they are previously extirpated, they may develop a darker complexion. It is even possible that the white inhabitants of the United States and Canada, were it not for the constant influx of European immigrants, might assume a complexion more and more assimilating to that of the Red-skins. But on these gradual effects of climate we are still very ignorant. Europeans who spend their lives in tropical or sub-tropical countries are found to be considerably darkened; but their children seem in all authenticated cases to revert to the ancestral type. The Arabs, however, who as members of the Semitic race are certainly not black by origin, are said in Nubia to vie in colour with the most jetty negroes. It is even said that there are black Jews on the south-western coasts of India. If this statement is capable of verification it is of the more value, as the Jews everywhere keep aloof from other races, and no influence of mixed blood need here be suspected.

A curious circumstance is that in many civilised countries the complexion of the population has darkened within historical times, even where there has been no immigration of dark races at all adequate to effect the change. The oldest records describe the populations of France, Germany, and Britain as fair-haired and of light complexions. The two latter countries especially have received an abundant influx of population from the north, and from the south but little. Yet in Germany the more or less dark-haired individuals form a respectable minority, in Britain probably a majority, whilst in France light- or red-haired persons are decidedly exceptional.

From all these circumstances we should argue, not by any means that Mr. Buchan's theory should be abandoned, but that we are here in presence of a "residual phenomenon"—of a something over and above what may be accounted for by temperature and degree of atmospheric moisture, and which invites further research.

V. CHEMICAL SHAMS.

By J. Hepburn Davidson.

Cam.—Was he not held a learned man?
Wol.—Yes, surely.
Cam.—Believe me, there's an ill opinion spread then, even of yourself, Lord Cardinal.

King Henry VIII.

In travelling through this vast world of toil, turmoil, and ill-feeling, we cannot help, as sufferers and on-lookers, feeling ashamed of some of the actors who play a leading part especially in Science, baffling the honest endeavours of those who are both morally and intellectually their betters, but have not yet secured a high pinnacle of position.

Academicians, Fellows of illustrious Societies, and heads of Science and Art Departments, make it one part of their business to pounce down upon the unwary scientist who fails to pay them due homage. How many men of merit are still suffering from dominant cliques the very same treatment which Lamarck met with from Cuvier, and Wolff from Haller! Who could not name a few such? A little bird once flew to a certain chemist, and chirped in his ear that he would have been elected a Fellow of the Carolinian Society had he only behaved more respectfully to Professor * * * * * *!

All this is the more unjustifiable because we fancy ourselves living in a free land, not a frank-land,* or land of serfdom, as of old. Yet there is a farm not one hundred

* "In the stye of this most bloody boar
My son, George Stanley, is frankt up in hold."

miles from the Albert Memorial where serf-chemists and serf-scientists in general are hatched in numbers, and sent out over the United Kingdom.

The serf-chemist contributes largely to the general amusement of youth. His display of fireworks and gaudy show of apparatus on the lecture-table do not fail to fascinate the juvenile eye. The roar of his hydrogen and oxygen cannon, as well as the roll of his matter-of-fact voice, with his general suave demeanour, have a powerful effect on both youthful and adult audiences, who look upon him as a prodigy of learning. A curious fact happened at one of those popular science lectures. The orator, in that polysyllabic dialect which mystifies the generality of his hearers, was illustrating the mode of producing hydrogen, as well as putting forth in learned garb the chemical theory of its liberation from sulphuric acid and zinc: he took the generator most gracefully in his left hand, and introduced with an ornamental sweep of the right a few pieces of the zinc, afterwards adding a more than sufficient amount of sulphuric acid at the highest specific gravity. Our lecturer then, with an air of confidence, corked the flask; the cork of course was perforated, and a piece of glass tube, drawn to a fine point, inserted. The apparatus was shaken vigorously, but no appearance of hydrogen! A look of mixed anxiety and chagrin passed over the pseudo's face, when a stentorian voice from the audience exclaimed "Stick in yer water, mon." Vulgar though the voice, its owner evidently knew more than the lecturer. Our serf had by this time recovered himself, and quietly said "I beg pardon, gentlemen; I had the full intention of introducing the water at first, but a new idea struck me, and I wished to verify it!" The next and most telling part of the lecture was the attempted illustration of the musical sounds caused by hydrogen. Our lecturer, having secured a length of combustion tubing, applied a taper to the hydrogen jet; but the result was a general explosion, the air not being completely expelled from the generator, and the acid was sprayed most effectually over the lecturer's coat, which in a short time showed that beautiful colour so often produced by sulphuric acid, and admired so much by pseudo-chemists in general.

It is humiliating to the scientific world, if we consider the amount of money annually spent in keeping up an Institution professedly to furnish the United Kingdom with properly qualified men, to find it sending forth a class of superficials who—after the magical passing of an examination—parade before us as certified science teachers and

guaranteed analysts. Nor are they slow at insulting and trying to cackle down every accomplished chemist who comes in their way, except he is connected with the farm aforesaid.

I know of an instance which cries seriously for the sympathy of scientific men, and which would call down public indignation if properly understood. A supposed impartial committee sent to inquire into a case of injured merit, actually sided with the oppressors as being the more influential party. After a series of gastronomic performances, in which the committee exhibited the "Science and Art" of eating, and after their personal vanity had been settled by dexterously managed fawning, a decision was then given against the injured party, who thus fell a victim to the jealousy of men professionally his inferiors! However, committees are but mortal, and are endowed with poor human natures, liable to wither when the conscience is dead.

Before leaving the serf type I must treat of one in particular, who has opened his palace of chemical entertainments in the remote regions of Scotland. This gentleman made a speciality of agricultural chemistry. After a very short period of incubation, at the English farm already referred to, he returns to his native soil, dons the broadcloth, and lectures to a set of shock-headed youths; thereby he acquires the name of a "clever mon." As his fame rises conceit keeps pace. Inspired by this conceit he encounters the educated and also the ignorant farmer, and astounds them with his learned, novel, and technical terms, in place of the plainer names which they are accustomed to hear. By dint of this fire of new verbiage he succeeds in making them believe that he is superior to his seniors and is versed in all the latest analytical processes, and thus secures samples to *analyse*. This *tyro* actually waged warfare against two well-known chemists, one of whom treated him with silent contempt, and the other carried on the contest. Although the second gentleman convinced men who knew their profession that the tyro was wrong, the latter still held his point with the most dogmatic assurance, earning the laughter of parties who watched the controversy. The result of this war was his losing caste in the eyes of many of his scientific brethren.

Let us hope our northern oracle will, like his national poet's "Nickie Ben,"—

"Tak' a thocht and mend."

The *medical* public analyst is another gentleman who generally stands high in popular estimation. In the eyes of the many the fact of his being a "*Doctor*" guarantees his abilities as a chemist. If the public only knew that the subject of their adoration had enjoyed only a six months' course of chemical lectures, at some University or College, during the winter session, and three months' practice during summer in qualitative analysis, and that as a rule very superficially gone through,—as very often students are not allowed the use of the regular laboratory, but extempore benches are fitted up in the lecture or tutorial room, and then only an hour is allowed for the class each day unless the pupil wishes to enrol himself for the regular laboratory curriculum,—what, then, would the public think, especially the trading community? Here, then, is our analyst, empowered to examine a sample of milk, sugar, or coffee, and the dealer is liable at any time, on the strength of his results, to be convicted and mulcted in a heavy penalty. What would our decent tradesman say if he understood what is, in contrast, the training of a really qualified chemist? He would say it was a piece of quackish presumption on the part of the medical man to hold such a post. We cannot, however, brand the whole medical world as not being trustworthy chemists, since some of our most able scientists belong to that honoured faculty. There are several—in fact, a great many—who after graduating almost entirely abandon practice, and give their whole heart and soul to scientific pursuits, looking upon their professional degree as a resource for a rainy day, and as the guarantee of a high class University education. There is one plea for the medical *pseudo* analyst, which is that no thoroughly qualified chemist will take the billet in the district where the medical man resides, as the retaining fee may be a miserable pittance barely sufficient to supply reagents, and the fee for each analysis perhaps as low as two and sixpence per sample; which, taken together at the year's end, would be barely sufficient to pay the rental of a laboratory and cover accidental breakage of apparatus. Fortunately the authorities of different towns are beginning to see the necessity of having a qualified chemist, as several dubious convictions have lately happened, and the idea current among private chemists who have analysed duplicates of the samples was that the defendants were innocent. One qualified chemist can now have his laboratory in the city, and yet be public analyst for several provincial towns, thereby leaving the *pseudo* medical analyst to his legitimate profession.

The chemical technologist—or, as he is commonly called, the works chemist—is the most down-trodden and injured individual in the profession. He is, in other words, treated as a mere analytical machine, subject to the control of often an ignorant master whose thick intellect cannot grasp the simplest rudiments of the science. In fact the master is a "rule-of-thumb man," and although his professional man makes an improvement it is pooh-poohed at through the routinism of his employer. It is the fate of many a sound chemist to be thus placed. A sample may be sent up to the laboratory, and the result "wanted without fail in two hours," though the analysis, if carefully done with the utmost expedition, would, we will say, take six hours. What is the result? Our honest, well-meaning chemist, who hates the stain of inaccuracy on his name, and looks to a *bona fide* character, falls into disgrace as an inefficient analyst. Put the *pseudo* chemist in his place, he receives the sample to be analysed with the coolest of manners, makes his weighings, and proceeds. If it is a mineral phosphate, he does not evaporate his acid solution to dryness, to expel hydrofluoric acid and render his soluble silica insoluble; he filters the silica off roughly, and, after a slight washing, proceeds to precipitate his phosphate of lime with a large excess of ammonia, thereby bringing a certain amount of foreign lime down mechanically with his precipitate. He does not overwash this precipitate, but places it—still saturated with ammonia—on the top of his copper water-bath. When nearly dry enough for ignition the filter is found to be dyed with a magnificent blue colour, which is neither more nor less than the copper dissolved by the ammonia. He ignites and weighs as pure tricalcic phosphate. In reality it is contaminated, perhaps to a high percentage, with oxide of iron and alumina, as well as oxide of copper from the water-bath. He draws out his report, and hands it to his employer a quarter of an hour before the time specified, and thereby gets the fame of an exceedingly clever fellow, because he is expeditious, and has given good (high) results which are to his employer's interests. The honest chemist cannot give such good results, neither can he do it in the same space of time, as his conscience forbids him to report oxide of iron and alumina as tricalcic phosphate, the removal of these bodies for the determination of phosphoric acid requiring some hours standing.

The reader may ask, what is the way to clear the atmosphere of our laboratories of the various types of *pseudo* chemists? Much of the mischief is effected by parents

pushing their sons into professions for which they have no natural aptitude or inclination. A child's development should be carefully studied, and the profession he is to follow should be deduced from his powers and his character.

As to professional jealousy, departmental tyranny, and the ignorant interference of employers, they will continue to the world's end. Would that our leaders would take Michael Faraday as their model, and, when hearing expositions of his merit, ask themselves in how far they are actuated by his spirit? He was a man loving Science for its own sake, rather than for the influence or reputation it brought him; loving, too, to give a helping hand and a kindly word to his brethren, and ready to recognise new truths even if uttered by the humblest.

VI. EXPLOSIVES.

IT seems probable that the science of Explosives will rapidly develop itself, and that public opinion, excited by late events, will have to pronounce on the restrictions it requires. Our present protection lies in the provisions of the "Explosives Act" of 1875; and experience suggests whether, at least in its exemptions, it does not require immediate revision. The purpose of the Act is to interpose the security of a license, and with it the supervision it presupposes; but the words of exemption, in Sect. 4, are that "the Act is not to apply to a small quantity for the purpose of chemical experiment, and not for practical use or sale." The six years since this Act was passed have changed the incidence of these words as words of exemption; and the advance of explosive science, it would seem, will practically put the preparation of many explosives out of reach of the Act, and out of control, by absolving them from the necessity for a license under this exemption clause. "A small quantity" is a term of proportion; it is relative; what is a small quantity for one purpose is large for another, and the contrary. A mere laboratory experiment is one thing, an experimental trial of an explosive is another. A tea-cup or a thimble might suffice for the one, vessels of capacity would

be required for the other. Yet fulminating gold and fulminate of mercury need only a very minute quantity to produce a frightful explosion; nitro-glycerine, as we have lately too well known, requires but a small quantity, and would be covered by this Section 4. On the other hand, since the introduction of the immense modern cannon, it is necessary to make powder with very large grain; the "pebble-powder" now in use is larger in grain than hazelnuts, and an experiment for its composition, though not manageable with "a small quantity," would yet be within the *ipsissima verba* of the Section as "a chemical experiment." Or such a thing as the new Russian war-powder, so different in composition from our "Waltham," will probably give rise to many "chemical experiments;" so, too, dynamite and gun-cotton, and other less known compounds.

The moral from all this is that the exemptions clause of the Act, with its indefinite term "a small quantity," and the misapprehension of which that is capable, should be replaced, possibly, by some measure of weight, or bulk, or volume, and that so indeterminate a phrase as "chemical experiment" should be narrowed by interposing at least the word "laboratory."

Perhaps still better would it be that no exemption be allowed, but a license required in all cases. It is more and more evident that the words "for practical use or for sale" do not reach the requisite restriction, especially at a time when England is charged with harbouring a certain class of explosives experimentizers.

It would have, however, to be fully considered whether these indefinite exemptions of the Act are not even yet preferable to a scale of measurement, which might be either too large for public safety or too small for any useful purpose. In other words, whether definition may not be inexpedient, and every case should be determined on its own merits by the evidence of experts. If it would be unreasonable to fetter chemical students, preparing for examination, with the necessity of a license, it would be worse, and it would be dangerous, to absolve the inventors of new projectiles from its safeguard.

ANALYSES OF BOOKS.

*The so-called Understanding of Animals, or Animal Instinct: a Popular-Scientific Study.** By Dr. LEOPOLD SCHUTZ, Professor at the Seminary for Priests at Treves. Paderborn: Ferdinand Schöningh.

HAVING for many years paid close attention to animal psychology we feel bound, in addition to our own observations and reflections, to take into account the writings of all men of science who have made this matter the subject of serious study. We were therefore very happy on receiving, through the courtesy of the publisher, a copy of Dr. Schütz's work. Our satisfaction was not the less, but rather the greater, because the first glance at the title-page convinced us that the learned author had arrived at conclusions widely differing from our own,—which, however, we are perfectly prepared to surrender if they can be proved incompatible with facts.

In the Preface we are at once confronted with a decided novelty. The irrationality of the lower animals is presented as something very like a dogma of the Christian Church. Those who uphold the mysterious notion of instinct are "combatants for pure truth and genuine science," whilst those who, like ourselves, consider the difference between man and beast as one of degree rather than of kind, are pronounced Materialists, "enemies of the Christian faith," and "mercenaries of a preconceived opinion or of a spurious illumination. Against these expressions, or rather against the vein of thought underlying them, we must earnestly protest. Had Dr. Schütz, in accordance with his duty, made a conscientious examination of the literature of the subject, he would have found that there is no necessary connection between the Instinctarian doctrine and Theism or Christianity, and in like manner that the belief in animal rationality is nowise a consequence of Materialism. Among the many writers utterly free from any leanings to Atheism, or to a denial of revealed religion, but who have been unable to shut their eyes to the overwhelming evidences of animal rationality, we may cite the late Archbishop Whately. He writes:—"It is quite clear that if such acts were done by men they would be regarded as an exercise of reason, and I do not know why when performed by brutes, evidently by a similar process, as far as can be judged,

* Der sogenannte Verstand der Thiere oder der Animalische Instinkt; eine populär-naturwissenschaftliche Studie.

they should not bear the same name. To talk of a cat's having instinct to pull a bell when desirous of going out at the door would be to use words at random."

Agassiz, also a Theist and a Christian, holds ("Natural History United States, I., i., p. 60) "that it is impracticable to draw any definite boundary between the faculties of a young child and those of a baby chimpanzee."

Cuvier, who is even accused by certain modern thinkers of an over-strained deference to theological tradition, says of the brutes:—"Leur intelligence exécute des opérations du même genre"—*i.e.*, as human actions.

Milton, an excellent logician, a profound student of and a firm believer in the Scriptures, puts in the mouth of an archangel these words —"They also reason not contemptibly."

Prof. Max Müller—no friend, be it remarked, of the doctrine of Evolution—writes, in his "Lectures on the Science of Language" (i., p. 402):—"Instinct, whether mechanical or moral, is more prominent in brutes than in man, but it exists in both as much as intellect is shared by both."

Lord Brougham, a writer on Natural Theology and editor of Paley, says, in his "Dialogues on Instinct" (Dialogue IV.):—"I know not why so much unwillingness should be shown by some excellent philosophers to allow intelligent faculties and a share of reason to the lower animals."

Such examples of Theists and Anti-Materialists, who refuse to explain the actions of brutes by the catch-word Instinct, might be multiplied indefinitely. On the other hand, everyone must have met with Atheists who reject with the utmost scorn the notion of reason in the lower animals. We regret, therefore, to be compelled to say that Dr. Schütz has put himself out of court by his Preface, which is either a proof that his acquaintance with the subject is deficient in thoroughness, or else a deliberate appeal to the *odium theologicum*.

The author's contention is summed up by himself in five so-called facts. He declares, first, "The animal does not reflect, does not need to reflect, and indeed never does reflect." This fact, we reply, is a gross error. Animals have in many cases been observed to reflect or consider,—to take extraordinary steps and measures under especial circumstances; they arrange stratagems available only at some particular time and place. Rats cannot long be caught by means of the same kind of trap. Birds avoid a scarecrow for a few days, and then discover its harmlessness. Prof. Leukart (Graber, "Organismus der Insekten," p. 249), in order to keep away ants from a colony of Aphides, besmeared the stem of the plant all round with tobacco-juice. These little creatures were not long checked by the abomination. They carried up grains of earth, and built a causeway upon which they could pass and repass at pleasure.

Prof. Gredler, of Botzen ("Der Zoolog. Garten," xv., p. 434),

gives an instance where ants got at some sugar purposely placed in a vessel hung by a string from the transom of a window-frame, by running up the woodwork and down the string. Afterwards they entirely abandoned this tedious route, a few of their number entering the vessel and throwing the sugar down to their comrades below.

A dog, set to fetch two hats, has been known to pack one inside the other. Such real facts prove Dr. Schütz's "erste Thatsache" to be a delusion.

The author's second fact is that "Many animals surpass man by the prudence and sagacity of their actions. That this is the case, and that the animals concerned still remain below the level of the human understanding, is similarly to be explained on the hypothesis of animal instinct." This fact, in so far as it is a fact, and where it does not find its explanation in the superior delicacy of the outer senses which many of the lower animals are known to possess, is merely what we observe among individual men. A B may be far below C D in the general level of his intelligence, but yet in some particular sphere of activity may far surpass him in foresight and sagacity.

The third assertion is that "The brute requires no instruction." This is simply incorrect. (*See* "Journal of Science," vi., p. 362). Old animals of every kind are more wary and cunning than young ones, as every close and conscientious observer can testify.

The fourth fact is that "The life of animals is non-progressive. How should an animal exceed the performances of its parents and forefathers, or fall short of them?" Here again we find palpable error. Had Dr. Schütz been either an observer or even a careful reader he could not venture upon such an assertion. Mr. Wallace ("Natural Selection," p. 227) shows that birds alter and improve their style of architecture according to circumstances. Dr. C. Abbott informs us that the common sparrow, introduced into America from England, has learnt to construct warm and commodious roosting-nests for protection in the severe winters. It is scarcely too much to say that this single fact suffices to overturn the theory of instinct in the traditional sense of the term.

Fifthly, and lastly, comes the assertion "The brute has no language." This also we must pronounce an error, as far as the higher animals are concerned. The instances where domestic animals have understood and acted upon remarks made by men, though such remarks had in them nothing of the nature of a command or a call which such creatures had been trained to obey, are numerous and perfectly authenticated. Now it is inconceivable that a being totally devoid of language, and therefore unqualified and unaccustomed to receive definite communications through any such channel, could understand the language of man.

There are, no doubt, animals literally dumb, devoid of sound-organs and of auditory appliances, and therefore incapable of mutual communication through the sense of hearing; devoid also of antennæ or feet, which might subserve a language of signs or touches. Between the absolute no-language of such animals and the rudimentary speech of birds and Mammalia there is a greater divergency than between the latter and the languages, *e. g.*, of the Veddahs of Ceylon.

We cannot help feeling some surprise that a work like that of Dr. Schütz should appear at the present day, especially in Germany, where accurate observers in Natural History are so abundant.

The Natural History of British Fishes. By FRANK BUCKLAND. London: Society for Promoting Christian Knowledge.

THIS work is intended not merely as a treatise on fish-lore, but as a manual of the art of fish-raising, The author rated highly, perhaps over rated, the importance of fish as an article of diet, and he exerted himself long and ably on behalf of the propagation and protection of such species as are particularly useful. Far be it from us to deny the value of his labours. Still, it seems to us that no possible increase in the multitude of food-fishes will make them fairly available for the great mass of the nation unless a scheme is devised for crushing out the middlemen who have seized upon the traffic, robbing alike the producer and the consumer and keeping up a system of artificial prices sometimes by dint of destroying whole cargoes.

The first thing which strikes us in the book is the account of a Nottingham "worm-farm" which sends to London 400,000 worms annually! The author believes that two young worms are sometimes produced out of a single egg.

Sewage, Mr. Buckland shows, is not necessarily deadly to fish. He states that "immense numbers of bleak can be seen at Oxford, at the point where the town sewer joins the Thames near Folly Bridge," and considers that they do an "immense amount of unpaid labour," doubtless by eating the putrescent solids. He observed the same fish also at the mouth of a sewer at Shrewsbury where the water was inky black from waste dye.

The viviparous character of the Blenny (*Blennius zoacces*), is a curious feature. Mr. Buckland recommends the young as excellent objects for the microscope for showing the circulation of the blood. The bull-head, it appears, sometimes proves fatal to king-fishers, as the spines on either side of the gill covers stick in the throat of the bird and choke him. Concerning the chub we read this singular passage:—"Why a chub has such a remark-

able skeleton I know not, and I should be much obliged if any of my readers could find out why the chub requires such a complicated system of bones." We quote this remark as characteristic of the author's vein of thought.

Feeding some tame cod-fish with a variety of matter he offered them a dead viper. when they all swam away! The following passage is significant:—"There seems also to be among fish, as among men, what the people in India call caste; that is to say a meeting of class A with class *Z* strikes a note of discord which no amount of the so much vaunted education of modern days will create into a concord." The conger eel Mr. Buckland thinks may have given rise to many of the stories of sea-serpents. Why is it, by the way, that in the south of England, the conger and the halibut are considered inferior to the cod, which, sauces apart, has as little flavour as a boiled dish-cloth?

On the "balance of life" (p. 73) the author over-balances himself. He tells us that "carnivorous animals have few at a birth, herbivorous animals many." We always thought that a cow, a ewe, or a goat never produced as many young at a birth as do the dog, the cat, or the semi-predaceous sow.

The gudgeon, we are told, are very fond of living in sewer-water, which would be immediately fatal to a trout or a salmon.

We find an abstract of the recommendations of a commission appointed in 1879 to examine into the herring-fisheries of Scotland. One of their conclusions was that "the Sea Birds Preservation Act, protecting gannets and other predaceous birds which cause a vast annual destruction of herrings should be repealed in so far as it applies to Scotland." Here is the difficulty in protecting animals of any class. What seems right from one point of view is objected to when considered from another. On p. 120 is the statement that nearly all the herrings taken in the Scotch fisheries were exported to Protestant countries, whereas the takes of Cornish pilchards were exported to Catholic countries. Mr. Buckland adds "there must be some good physiological reason for this curious fact!" A little further, in a chapter on the lamprey we meet with this singular sentence:—"On the Loire, as at Gloucester, they make them into pies, and are said to be exceedingly good."

The common stories about the longevity of the pike are dismissed as fabulous, though it does not appear upon what evidence save "improbability." Concerning the attendance of the pilot-fish (*Naucrates ductor*) upon sharks, Mr. Buckland suggests that its object is very probably to pick parasitic vermin off the shark's body. In the chapter on the sole we meet with a fact not generally known:—"Young plaice and soles when first hatched out always swim on their edge for about a week, and in this condition have their eyes upon different sides of the head." The old tradition that the tench is the pike's physician is rejected, for the author, like Waterton, can be sceptical as well as credu-

lous. In this instance he adduces conclusive evidence that young tench are a successful bait for pike. The sections on the systematic management of fish-ponds and on the acclimatisation of desirable species of fish are exceedingly important. In short, the entire work is replete with most valuable matter ranging from acute and original observations on the habits and anatomy of fishes to useful cookery receipts. It is eminently readable and presents in full luxuriance the properties which endeared its author to a wide circle of friends.

We wish our task could end here. But Mr. Buckland unfortunately enters upon the philosophy of biology—a theme for which he was totally unqualified, and seeks to defend the old doctrine of individual, mechanical creation. Had he any new line of argument to bring forward we should have been most happy to give it our most serious attention. But the "Bridgwater" argument in which he indulges is to be regretted, since the easy refutation to which it is open plays into the hands of the materialist school. Thus he points to "above all, the enormous fertility of fishes useful as food to the human race." If so, what is the inference to be drawn from the "enormous fertility" of animals hurtful to the human race? Further, it is by no means absolutely proved that man is adapted to an animal diet. There are those who contend that he was designed to support himself upon a purely vegetable regimen, and that by adopting carnivorous habits he has brought upon himself many evils, physical and moral. Still more to be regretted is the insinuation that "certain modern ideas of creation" are prompted by "pride of intellect," which cannot humble itself enough to accept on faith itself the fact that "The sea is His and He made it, and His hand prepared the dry land." Does it yet require to be shown that this is an utter misconception of the Evolutionist point of view?

The Ventilation of Dwelling-Houses, and the Utilisation of Waste Heat from Open Fireplaces. By FREDERICK EDWARDS, Jun. Second Edition. London: Longmans and Co.

WE have here an interesting and able contribution to the literature of a very serious subject. Ungenial seasons and dull trade are forcing increased thrift upon all classes, and it is becoming doubtful how long we can afford to indulge in our twin national extravagances of "cheerful" fires and "plain" cookery. Furthermore, the growth of the smoke-nuisance and the alleged increase of fog in our cities are creating a degree of excitement rarely awarded in this country to any subject of a practical non-hysterical character. We can only hope that the public feeling will not die out without leading to some definite results, and

that the nation will listen to sound common-sense advice, such as that of our author, rather than to the teachings of sensationalists.

The outline-history of ventilation in this country is not without a melancholy interest. We are introduced to one Sir Jacob Ackworth, whilom Surveyor to the Navy, a man who carried his opposition to improvement and discovery beyond the boundaries of candour and honesty. Dr. Desaguliers had devised a machine for ventilating the holds and 'tween decks of ships, in place of the traditional wind-sails, which were of course useless either in a calm or a storm. Sir Jacob was requested to report on certain experiments at Woolwich. "He began by throwing difficulties in the way, and he avoided witnessing an experiment when the Doctor was present. When he did attend he chose a time when plenty of wind was blowing. He had his favourite wind-sails hoisted, and said to the Doctor's representative—'I would have you work the engine, and see whether that will throw out so much air as our wind-sails do.' The man with astonishment replied that the blowing-wheel was to be used when the sails were useless. But Sir Jacob stuck to his prejudices, and would not stay any longer." He afterwards wrote a report condemnatory of the invention, without having ever seen it.

In 1739 Mr. Sutton, a brewer, hearing of the anti-sanitary condition of the Fleet, devised an ingenious plan of making the fires of the ships' coppers draw their supply of air from the hold, thus keeping up a thorough circulation whenever the coppers were in use. He, too, had to encounter Sir Jacob, who tried every expedient to thwart him. But Mr. Sutton was not to be tired out. An official experiment performed at Deptford, before the Lords of the Admiralty and several members of the Royal Society, succeeded in spite of Sir Jacob. Still, in the end, official obstructiveness and indifference carried the day. The system was not introduced, and two years after the decisive experiment the Lords of the Admiralty offered Mr. Sutton £100 for the trouble and outlay which he had incurred!

It must not be supposed that Sir Jacob Ackworth is dead. We have known him, when commissioned to report on a system of sewage-treatment, carefully select a time of flood when the volume of water was far greater than the tanks could possibly receive. But Sir Jacob gravely took his samples for analysis, and as gravely published the results as a proof of the inefficiency of the process. On the other hand, in case of a method of dealing with sewage which he favoured, we have known him just as carefully select the most favourable weather.

On another occasion, a certain person who is no chemist "wrote to the papers" that metallic salts are incapable of precipitating dissolved impurities from water. Sir Jacob at once printed the rash statement, and when a chemist of European reputation asked, in reply, for the evidence upon which this

assertion was based, his letter was consigned to the waste-paper basket.

Sir Jacob is, in short, an influential, prosperous humbug. He edits journals, political, literary, "society," and even—*proh pudor!*—scientific. He is on the council of our learned societies, and always recommends himself for re-election. He is active in organising exhibitions, and some even say that he is the unseen head of a "department."

Mr. Edwards appears to have come in collision with this evil genius. He, too, has occasionally written to expose some error or absurdity, but Sir Jacob's influence was sufficient to ensure the rejection of his communications.

The author's proposals for the better economy of heat are for the most part highly judicious. He recommends for windows double panes of glass, placed about a quarter of an inch apart, or, for larger rooms, double sashes with an interval of five to six inches. Experience in various countries has abundantly proved that such arrangements materially check the loss of heat in winter. At the same time they involve a loss of light, an article not too abundant in the narrow streets of our smoky cities. And as long as the woodwork of the windows and doors is executed by "contracting" masters and trades'-unionist workmen, so long will it admit plentiful currents of cold air. A more important feature is the proposal to utilise the warm air from the fires in the lower stories of a house, for the benefit of the rooms situate above them. It is generally admitted that from three-fourths to seven-eighths of the heat evolved by combustion of coal, in our open grates, escapes up the chimney. But here it is confined within a stack of masonry of such thickness that its effect upon the temperature of the rooms above is practically null. Mr. Edwards proposes to convey it upwards by means of cast-iron pipes, so that it may give off a large proportion of its heat in the house. We like this proposal; but we doubt whether it is capable of adaptation to houses already built. In another respect we are compelled to differ from him. He thinks it hopeless to induce the English public to take to close stoves. We reply that the experiment has never been fairly made with the earthenware stoves used in various parts of the Continent, which have many advantages over those of iron.

Mr. Edwards criticises certain recent proposals and improvements, so-called, for warming dwelling-houses in a masterly manner. He shows the absurdity of the fire-grates on a level with the floor, which, in utter defiance of scientific principles, have been foisted upon the public within the last half-century. This is the fatal objection to the "Country Parson's Grate," which, in addition, requires a very high class of fuel. It has, however, the advantage, as our author shows, of minimising the quantity of iron placed in contact with the fire. The "Norwich" or "Slow Combustion Stove" has the defect of a solid bottom

the chief point in which it differs from ordinary grates. If the regulator in the chimney is not attended to, and the "blower" used, it consumes a very serious quantity of fuel, and roars like a furnace. The author's own grate for dwelling-rooms is difficult to describe without the aid of diagrams. Like Dr. Arnott's, it is kindled from above. For kitchens he, at any rate, condemns open fires, and recommends that the boiler for supplying hot water, the oven for roasting and baking, &c., should be heated by closed furnaces fed with coke or anthracite. It is, however, the question whether most cooking operations may not be performed with more economy and cleanliness by means of the gas-ovens devised by Mr. Fletcher.

One difficulty remains: in thousands of houses the open fire in the kitchen has to serve the purpose, in all times of wet weather, of drying linen on "washing-day." This duty, we fear, cannot be well fulfilled either by the gas-oven or by a closed stove.

We fear, however, that the difficulties in the way of any thorough improvement in the warming and ventilation of our houses, and indeed of all matters connected with domestic sanitation, are rather of a sociological than an engineering nature. Nevertheless Mr. Edwards has done a good service in bringing so many neglected truths before the public, and we much regret that in certain quarters he has been encountered with the "conspiracy of silence."

General Physiology of Muscles and Nerves. By Dr. J. ROSENTHAL, Professor of Physiology in the University of Erlangen. London: C. Kegan Paul and Co.

WE have here a summary of what has been done in a special, important, and difficult branch of biology. Everyone knows that an explanation of certain processes in the animal system—such as digestion, respiration, and secretion—necessarily involves an appeal to chemistry. In a very similar manner the functions of the nerves and muscles can be studied only by the physicist. The author, after an introductory chapter, in which he pronounces movement and sensation as animal characteristics, in so far at least that special organs for movement—muscles—have never yet been traced in plants, gives an account of protoplasmic amœboid, and ciliary motion. He then describes the form and structure of muscles, their connection with the bones, their elasticity, irritability, the generation of heat during their action, their alteration in elasticity, exhaustion, and recovery, and the source of the force which they display. This is traced to chemical changes within the muscle itself, and affecting not so much the

albuminoids as the glycogen and inosite. The smooth-fibred muscles, which subserve the involuntary movement of the system, such as peristaltic motion, are next described, with the admission that our knowledge of their nature is as yet very imperfect.

We come now to the nervous system, described as consisting of fibres and cells. It is inferred that excitement in the nerve is due to a change in its molecular condition, and occurs as soon as such a change is effected with sufficient speed.

Dr. Rosenthal then proceeds to examine a class of phenomena common to both muscles and nerves, in contradistinction from other animal organs and from the tissues of plants, *i.e.*, their regular and powerful electric action. In three fishes—the torpedo of the Mediterranean, the electric eel of South America, and the *Malapterurus electricus* of the Bay of Benin—this function of muscular and nervous tissue is intensified by special structural arrangements, so as to form a battery and to serve as an offensive weapon. It appears that every muscle, and part of a muscle, when at rest, is positive on its longitudinal section and negative on its cross section. In a regular muscle-prism the positive tension decreases regularly from the centre of the longitudinal section toward the ends; and the negative tension does the same in the cross sections. During the activity of the muscle the differences in tension decrease. Entire muscles often exhibit but slight differences in tension, or even none at all. Nerves are positive on the longitudinal section, and negative on the cross section. During activity the differences in tension decrease.

The question is discussed whether the muscles are irritable directly, independent of the nerves, or only indirectly, and through the mediation of the nerves. The author considers this point as not decided, but suggests that these two classes of organs, so similar in most other points, may agree in irritability.

Turning from the motor-nerves, we come to three kinds progressively more difficult to understand—the secretory or gland-nerves, the nerves of sensation, and the retardatory nerves. As regards the process by which molecular movements in the nerve-cells can be translated into consciousness, Dr. Rosenthal, with Du Bois-Reymond, admits complete ignorance. The notion of Schopenhauer, who ascribes sensation and consciousness to all molecules, seems to him, as it does to all men of sound mind, but a questionable gain. Nor does he consider the question whether conscious conceptions can arise in the nerve-cells of the spinal cord as fairly open to scientific discussion. He points out the error of supposing that the sense-nerves are specifically different and irritable, each by some definite influence alone. It is not, *e.g.*, the optic nerve, but a special terminal apparatus in the retina, which is sensitive to light.

A common error is next exposed. Our sensation of light bears

no likeness to the physical process of the ether vibrations which give rise to it. These ether vibrations are the one and the same, though, according to their subjective effects, we call them sometimes heat and sometimes light. "The usual classification of physical processes into those of sound, light, heat, &c., is irrational, because in these processes it gives prominence to an accidental circumstance,—that is, to the way in which they affect human beings, who are endowed with various sensations, whilst in others, such as magnetic and electric processes, it is based on quite different marks of classification."

The rate at which excitement is transmitted along the sensory nerves is not only much slower than is popularly supposed,—30 metres per second,—but it varies in different persons, in the different senses, and according as the excitement is or is not expected. These measurements, it is suggested, represent the crude beginnings of an experimental and physiological psychology. To what will they grow?

We must pronounce this work an exceedingly useful compendium. If we have an objection to urge it is that relatively too much space has been given to the muscles and to the motor-nerves, and too little to those mediating sensation.

Experimental Researches on the Temperature of the Head. By J. S. Lombard, M.D. London: H. K. Lewis.

It will be known to many of our readers that Dr. Gray, M. Broca, and MM. Maragliano and Seppilli had come to the conclusion that the left side of the brain has uniformly a higher temperature than the right. Dr. Lombard has carefully re-investigated the question, with negative results. He finds, from a very prolonged and extensive series of observations, the particulars of which are here tabulated, that the rises and falls of absolute temperature, by which the balance of superiority of temperature is shifted from one side to the other, or by which equality is brought about, follow no definite law, but are governed by agencies liable to constant variation. As the absolute temperature rises, the average difference between the two sides seems to diminish, but the exceptions are so numerous that the author lays little weight uoon this generalisation.

In a second treatise, Dr. Lombard, assisted by Dr. F. H. Haynes, examines the effect of voluntary muscular contractions upon the temperature of the head. It appears that Dr. R. W. Amidon has recently sought to prove not merely that voluntary muscular movement causes a marked rise of temperature at the

surface of the head, but that the contraction of different muscles affect the temperatures of different well-defined areas of the integument of the head, each muscle having a special thermic centre in the cortical substance of the brain, the temperature of which centre is increased when the muscle acts in a degree sufficient to produce a change of temperature in a circumscribed area of the overlying integument, appreciable by means of instruments of no great delicacy. Dr. Lombard and Dr. Haynes find, on the contrary, a rise of temperature in fewer than 4 per cent of their experiments, whilst the cases in which a fall took place were more than five times as numerous. It would seem, however, that in many cases muscular movements disturb the temperature of the head, causing either elevation, depression, or irregular fluctuation.

In a third course of researches Dr. Lombard examines the influence of the temperature of the air upon the temperature of the head. He finds that as the average atmospheric temperature declines, that of the head falls also, though in a very much smaller proportion, a decrease of 11·9° C. in the temperature of the air being accompanied by a fall only of 1·6° C. in the temperature of the head.

The Collected Works of James MacCullagh, LL.D., Fellow of Trinity College, and Professor of Natural Philosophy in the University of Dublin. Edited by J. H. JELLETT, B.D., and SAMUEL HAUGHTON, M.D. Dublin: Hodges, Figgis, and Co. London: Longmans and Co.

THE memoirs contained in the present volume are chiefly reprinted from the "Proceedings and Transactions of the Royal Irish Academy." The subjects dealt with are Geometry and Physical Optics, treated from a mathematical point of view. Among the principal of these papers are "The Double Refraction of Light in a Crystallised Medium according to the Principles of Fresnel," "The Intensity of Light when the Vibrations are Elliptical," "Conical Refraction," "Recent Investigations concerning the Laws of Reflection and Refraction at the Surface of Crystals," "Laws of Reflexion from Metals," "Laws of the Double Refraction of Quartz," "Laws of Reflexion from Crystallised Surfaces," "Probable Nature of the Light transmitted by the Diamond and by Gold-leaf," &c. These memoirs are all perfectly well known to those engaged in the study of Optics, so that any examination of their merits would seem an impertinence.

As an Appendix we find two papers on Ancient Egyptian

History. In one of these the author fixes the departure of the Israelites from Egypt at B.C. 1322, and identifies the king, who in pursuing them lost his army in the Red Sea, with Ocaras.

The Weather of 1880 *as observed in the Neighbourhood of London* By E. MAWLEY, F.M.S. London: Bemrose and Sons.

WE have here a most useful summary of meteorological observations for the past year. The author is not merely a student of the weather, but a zealous horticulturist, being Honorary Secretary of the National Rose Society, and he consequently regards the peculiar character of the season under what is its most important aspect, viz., its influence upon organic existence. The year itself, though an improvement upon its dismal predecessor, can scarcely be pronounced satisfactory. It began with severe and unseasonable cold, which proved injurious to many trees and shrubs. The two decisive summer months, June and July, were cold, wet, and windy; and although August fortunately displayed a low rainfall, it was dull and cloudy. The amount of atmospheric moisture was remarkable, especially as being unaccompanied with a corresponding downfall. Snow and exceptional cold came on in October, a temperature of 29·3° F. being realised on the 24th. Whilst the mean temperature of the air was 0·1° above the average of the last thirty-nine years, that of the soil 3 feet below the surface was 0·4° below that of the last thirty-three years. The nights in which the minimum temperature on grass fell below freezing-point reached the serious figure of 136. Rain fell on 166 days to a depth of 3·20 inches in excess of the last twenty years; 81 days were entirely sunless, and the average duration of sunshine was only 3 hours 37 minutes daily.

We hope that Mr. Mawley will find his valuable labours duly appreciated, and no less do we trust that he will have a more cheerful account to render of the season now in progress, though it has made but a poor beginning.

A Treatise on Fuel. By ROBERT GALLOWAY, M.R.I.A., F.C.S., &c. London: Trübner and Co.

THE need of a work on Fuel has long been felt by manufacturers, and in order to meet this want Mr. Galloway has put into book-form the subject-matter of a course of lectures delivered by him,

in the Royal College of Science for Ireland, while Professor of Chemistry in that Institution; the result being the treatise now before us, containing 136 pages, and about a dozen excellently executed woodcuts, drawn to scale, including Dr. Siemens's Regenerative Gas-Furnace.

The chapters dealing with the Technical Examination and Analysis of Fuel, Pyrometers, and the Regenerative Gas-Furnace are those in which we were particularly interested.

There are some points on which we might have expected greater fulness, but as regards clearness of description nothing is to be desired. On the whole we congratulate Mr. Galloway on his undertaking, and can recommend the work as a very useful companion to the technological chemist, as well as to the manufacturer who is interested in the question of the economy of fuel.

ERRATUM.

Page 243, line 13 from bottom, *for* "lumi in germs" *read* "luminiferous ether."

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

DISCORD AMONG EVOLUTIONISTS.

To the Editor of the Journal of Science.

SIR,—Has it ever struck you as an upleasant fact that modern naturalists or evolutionists—for the terms are nearly synonymous—wash far too much dirty linen in public, and, not content with criticising opinions, indulge in needless personal ties? Among the offenders Prof. Haeckel takes a foremost place. Witness his comments on Du Bois-Reymond's "Grenzen der Natur-erkentniss," to be found in the Preface to the "Evolution of Man"; his notice of Vogt and of Semper, in the same work; his ascription of a "diseased imagination" to A. R. Wallace; his condemnation of Agassiz, as insincere, "gifted with too much genius actually to believe in the truth of the mystic nonsense which he preached." Prof. Haeckel's comments on Herrn Reichert and Goethe are in one sense perhaps justifiable; but it may well be asked whether these writers deserve notice at all?

We have then, on the other side, Prof. Semper's work "Haeckelism in Natural History." Dr. G. H. Schneider's strictures on Prof. Dohrn, of the Naples Aquarium, go, to say the least, beyond the boundaries of courtesy. The attacks of Mr. S. Butler, and even those of Prof. St. George Mivart, upon Mr. Darwin (*see* "Lessons from Nature") seem to me open to the same objection.

If naturalists would bear in mind how greatly their difficult task is impeded by such outbreaks, and what delight these bickerings afford to the enemies of scientific progress, they would, I think, be more mindful of the *suaviter in modo*.—I am, &c.,

B. R. P.

A FIRST CAUSE.

To the Editor of the Journal of Science.

SIR,—Can you, or any or your anti-monistic contributors, produce a reply to the following argument of Dr. Büchner's?—"It is evident that a force can only exist in as far as it is active; but a creative force, the first cause of the world, could therefore exist neither before nor after creation, since both before and after this act it would have to be inactive, and inaction is irreconcilable with force."—I am, &c.,

A LUCRETIAN.

CHEMISTRY AND THE SEXES.

To the Editor of the Journal of Science.

SIR,—I expected to have been able to supplement my paper on the "Materialism of the Sexes" with one on "Life," and to have answered my critic, F. G. H., therein; but pending its preparation I will reply now, lest he mistake silence for consent.

1. How oxygen upsets my analogy I fail to perceive, nor does he explain. The *elements* are dual, but *one* element is not.

2. Because Berzelius recognised that the grouping of the elements was only a *relative* distinction, does that bind the world to eternity to accept Berzelius as an infallible authority?

3. F. G. H. denies that both classes of metallic and non-metallic elements are necessary to the formation of productions, and cites sodium amalgam, adding parenthetically his own contradiction, for he says it is attended with the production of "flame." If F. G. H. will show the world how flame can be produced without the assistance or participation in it of the above dual classes, his fame is made.

4. F. G. H. is facetious because I describe air as a "dual *combination* of oxygen, nitrogen, and *hydrogen*"! What his objection exactly is, is not clear. Whether *three* elements combining—although two are of one class, and one of another—is not a *dual* combination, or whether he denies *hydrogen* to be a constituent of air, no one can gather from his sentence. Perhaps he knows what he means himself, but the object in writing is usually to make others divine the meaning clearly.

5. The critic's last sentence is the strangest of all. Because compounds have properties "totally" different from their ele-

ments, therefore we should not seek in the elements for the properties of a compound such as protoplasm. As the properties are not "totally different," but merely *varied*, the statement shows F. G. H. is ignorant of the properties of the elements; and further, if we are not to examine the elements of protoplasm to discover its properties, we suppose neither are we to examine bricks and mortar to see whether a building is to be erected durably or not.—I am, &c.,

AND. DEWAR.

THE EVOLUTION OF THE CHEMICAL ELEMENTS.

To the Editor of the Journal of Science.

SIR,—It has often been remarked as a curious fact that elements closely allied in their properties are very commonly found together in Nature, as is shown in the case of nickel and cobalt, of sulphur and selenium, and, above all, of the earths in Samarskite. I am not aware, however, that the bearing of this fact upon the question of the origin of the elements has ever been taken into consideration. If the elements have existed as distinct bodies from all eternity, or have been separately created, what is the likelihood, according to the doctrine of chances, that those most similar to each other should occur in close juxtaposition? Surely very small! Nor can it well be contended that they have been brought together by the force of chemical affinity, which acts between the unlike rather than between the like. But if we suppose that the elements have been formed from some original material or materials, we can well expect that bodies differing but little in their nature should be formed under the action of nearly identical circumstances, and should consequently occur together locally, just as is the case with organic forms.—I am, &c.,

ABNORMAL.

DR. R. LEWINS, as the author of the work referred to ("Journal of Science," April, p. 202) by Frank Fernseed, wishes to point out that his meaning has been misapprehended. He does not object to qualified men devoting their time to research so long as their powers admit, and is very far from proposing any restrictions upon Science.

NOTES.

In a paper on the History of the Solar System, communicated to the Royal Astronomical Society by Mr. G. H. Darwin, F.R.S., the author concludes that the orbits of the planets round the sun can hardly have undergone a sensible enlargement from tidal friction since these bodies attained a separate existence. He holds that his investigations show no grounds for the rejection of the nebular hypothesis.

Dr. A. Wilson, F.R.S.E., in a paper read before the Royal Institution, contended that the original condition of organisms is "colonial." The universal segmentation of the egg is a proof of this inference, and the development of new forms by this so-called process, in Gregarinæ, &c., supports this conclusion. The lower we proceed in the scale of being the more marked is the tendency to form "colonial" organisms. Arrest of development, by causing an organism to cease progressing at a segregated stage, will tend to produce a "compound" and "colonial" constitution. The plant world is colonial in its highest types. A tree is in many respects as markedly colonial as a volvox. The highest animals exhibit lingering traces of an originally colonial nature in their histological composition. The tendency of life-development is towards concentration and the conversion of the colony into the individual. It is suggested that the theory and idea of an originally colonial constitution may explain the existence, in man and higher animals, of tribal and family associations. The semi-independent action of many parts of the higher brain receives an explanatory hint as to its cause from the idea of an originally independent and colonial constitution.

Dr. Beale's attack upon Darwinism, delivered on resigning the presidency of the Royal Microscopical Society, will not be printed for distribution as is usual on such occasions.

The said Microscopical Society has become the subject of comment in connection with the Quekett Medal Fund, and the rejection of the offer of a Fellow to found two annual medals, one for improvements in the microscope, and the other for microscopical research.

In the "Archives de Biologie" (Belgian) M. Jules McLeod gives an interesting account of the poison-apparatus of spiders.

According to "Forest and Stream" oysters are sometimes rendered dangerous and various fishes are poisoned by the discharge of poisonous gases from the bed of the sea.

The "American Naturalist" gives an account of *Dysodus pravus*, the Japanese lapdog. Though differing generically from *Canis*, it appears to interbreed freely with the common dog.

M. A. Muntz, in a communication to the Academy of Sciences, shows the presence of minute traces of alcohol in natural waters and in soils rich in organic matter. He concentrates by fractional distillation, converts the alcohol into iodoform, which is then recognised microscopically.

According to the researches of Bonnet ("Biedermann's Central-Blatt") the blood reaches its minimum daily temperature between midnight and 3 a.m. The maximum temperature is observed between 2 and 4 p.m., though in permanently hot weather it may be delayed till 8 p.m. Neither sleep nor wakefulness, hunger nor satiety, neither age nor sex has any influence.

According to the experiments of Mr. F. Hatton, reported in the "Medical Press and Circular," bacteria are capable of living in contact with atmospheres of hydrogen, nitrogen, carbonic oxide, carbonic acid, sulphurous acid, nitrous and nitric oxide. Cyanogen proved fatal at first, but on its decomposition the bacteria revived and multiplied. Salicylic acid, strychnine, morphine, narcotine, and brucine had no perceptible action. Phenol, alcohol, spongy iron, and permanganate are said to have a very destructive effect on bacterial life, though in the next sentence Crace Calvert is said to have previously shown that bacteria can live in strong carbolic acid.

Peace appears to have been restored in Guy's Hospital, and nursedom is henceforth to remain in becoming subordination to the medical staff.

The University of St. Andrews has given in its submission to the Women's Rights agitators.

Mr. A. B. Wynne, F.G.S. ("Geological Magazine") considers extensive glaciation at low levels in the north of India improbable.

In consequence of the number of sheep worried, the Legislature of Missouri have passed no fewer than twenty-two Acts relating to dogs last winter, and about half as many more Bills on the same subject have been introduced in the present Session.

We are happy to learn that a Bill for the suppression of physiological experiments, introduced into the Legislature of New York, has been thrown out.

The "Medical Press and Circular" states that Mr. Dodson, President of the Poor Law Board, has instructed the Oldham Guardians to use their own discretion as regards the prosecution

of parents who have been summoned more than once for refusing to have their children vaccinated.

We learn that C. H. Kehnroth, one of the professors at Dr. Buchanan's College, was sentenced, on February 12th, to one year's imprisonment, for issuing "bogus" diplomas—a very moderate penalty.

According to Prof. James Law, small-pox is exceedingly common among pigeons and poultry in India and Italy.

We regret to find, in the prospectus of the forthcoming Exhibition at the Crystal Palace, "birds of paradise, humming-birds, and other bright-plumaged birds" figuring in Class X., among "raw materials for clothing, ornament, or fabric."

Nies and Winkelmann show that solid tin floats upon melted tin, just as ice does upon water.

Several eminent authorities maintain that spectral lines are atomic spectra, whilst bands are molecular spectra.

L. J. Templin ("Kansas City Review of Science"), after a survey of the history of the vegetable kingdom, maintains that the rule of development that has governed in the introduction of higher forms has been by sudden jumps, and not by gradual modification.

According to the Paris correspondent of "Science" a criminal who had been executed by hanging was completely restored to consciousness by a powerful electric current, but succumbed, on the second day following, to cerebral congestion.

Dr. B. Joy Jeffries has made a careful examination on the prevalence of colour-blindness among the school-children in Boston. He finds this defect in 4·202 per cent of the males, and in only 0·066 per cent of the females—results agreeing substantially with those obtained by the most careful observers in Europe.

Prof. J. M. Long, writing in the "Kansas City Review of Science and Industry," remarks that Evolution claims to be the explanation of proximate causes, laws, and origins, not of ultimate ones. The opponents of Evolution seem utterly unable or unwilling to understand this distinction.

A new insect pest is said to be committing grievous havoc in the olive grounds of the south of France.

Dr. R. S. Ball, F.R.S., in a lecture delivered at the Royal Institution of Great Britain, remarked that the star Groombridge (1830) is either a runaway, or the masses of the bodies in our system must be much greater than it has been assumed.

Prof. Bredichin ("Monthly Notices of the Royal Astronomical

Society") infers that the tails of the three types of comets are composed respectively of iron, hydrogen, and carbon.

The milk of cows takes a reddish colour if they have eaten the leaves of madder or of *Galium verum*.

M. W. Koster ("Archives Neerlandaises des Sciences Exactes et Naturelles) shows that there is no specific difference between the muscles of the hand in man and in the anthropoids. (See, also, "Verslagen en Mededeelingen d. K. Akad. v. Wet.," 2 Ser., t. XIV.)

Certain human bones, found imbedded in an undisturbed clay at Nice, apparently belonging to the quaternary epoch, are ascribed by M. de Quatrefages to the Cro-Magnon race.

According to "Les Mondes" the photophone is applicable to the study of the Aurora Borealis.

During the past year 422 students have received instruction in Applied Physics and Applied Chemistry at the Cowper Street Schools, in connection with the City and Guilds of London Institute. The income of the Institute for the year 1881 will be not less than £18,515.

According to Von Nägeli and O. Loew the lower Fungi can derive nourishment from alcohol, phenol, salicylic and benzoic acids.

Among the recently observed noxious insects must be reckoned *Gelechia cereabella*, a moth belonging to the Noctuidæ, which in its larva stage injures barley; and a Hemipterous insect, *Lygæus leucopterus*, which has committed enormous ravages in the wheat district to the south of Lake Erie.

A paper on the "Increasing Number of Deaths from Explosions, with an Examination of the Causes," was read before the Society of Arts, March 23rd, by Mr. C. Walford, F.I.A., F.S.S., Barrister-at-Law. The learned author directed attention merely to boiler and coal-mine explosions, but the general feeling was that the public is not sufficiently protected.

M. Toussaint, of the Veterinary School of Toulouse, has devised a method of protecting sheep against splenic fever by means of preventive inoculation.

According to M. S. P. Langley ("Comptes Rendus") the maximum of solar energy, prior to the absorptive effect of the atmosphere, is found nearer the violet than the ultra-red. The totality of the solar radiations would give a sensation of blueness rather than of whiteness.

M. E. Mercadier, in the same journal, shows that the radiophonic sounds produced with the selenium-receiver are due to luminous radiations.

M. Crova, in a paper read before the Academy of Sciences, shows that elevated temperatures can be measured by means of the spectro-pyrometer—a modification of the spectroscope.

Valdivine and cedrine, principles extracted from the so-called cedron-nuts, are utterly useless as a remedy for the bites of serpents and for hydrophobia.

According to M. J. Chatin ("Comptes Rendus") trichinæ may occur, in the encysted state, in the fatty tissues of animals, as well as in their muscles.

MM. J. Béchamp and E. Baltus, in a communication to the Academy of Sciences, prove that recent pancreatic microzymas injected into the blood of an animal occasion rapid death as soon as their proportion reaches 0·0001 gramme per kilo. of its entire weight.

M. Letourneau laid before the Société d'Anthropologie, of Paris, some details concerning the sailor Pelletier. He had been shipwrecked when twelve years of age on the coast of Australia, and had become completely assimilated to the savages among whom he had lived. When questioned by the French Consul at Sydney, he wrote the name of his native place and that of his ship in one word. He tried to write to his father, but what he wrote had no meaning. In a few days he recollected some fifteen to twenty French words.

From the reply of Mr. Gladstone to a society for the prevention of "cruelty to animals," there is just reason to fear that further restrictions will be put upon physiological research, the Liberals completing the evil work which the Conservatives began. "A plague on both your houses!"

We regret to learn the death of Mr. E. R. Alston, Secretary of the Linnean Society, and one of the contributors to the "Biologio Centrali-Americana."

Science has sustained another loss in the decease of Mr. F. A. Nobert, well known for his delicate micrometers and test-plates.

The "Medical Press and Circular" records the fate of a country woman who made cheese-cakes of arsenic, mistaking it for pounded rice!

The "Revue Internationale des Sciences Biologiques" criticises M. Pasteur very severely, noting especially the aureola seen under the microscope, apparently surrounding certain bacteria.

From the same journal we learn that M. Bouley, for whom a chair of comparative pathology has been just created at the Museum of Natural History, seems more pre-occupied with financial questions than with scientific research.

Dr. M. C. Cooke, in calling the attention of the Quekett Club to some Desmids new to Britain, gives an account of the best method of preserving them permanently for microscopical observation. The most important object to be secured in mounting Desmids is rather the preservation of the empty frond, as for scientific purposes this is often of superior value to one filled with endochrome, as it permits the *punctæ* or markings of the segments to be seen, which are obliterated whilst the endochrome remains. For the study of the endochrome alone of course its presence is most important; but this can be done, and drawings made from the plant in the living state, and if specimens can be mounted with the endochrome unchanged and uncontrasted so much the better. One great difficulty in mounting objects with such thin and delicate cell-walls as Desmids is to employ a medium of no greater density than the cell contents. If a denser medium, such as glycerin, be used, the endochrome immediately contracts, and never expands again as before. Water, or water containing a little camphor, is of equal density, and no change can be detected. After all, the preservation of the endochrome is of less importance than the perfect contour of the cell. If there is any contraction or collapse the objects are useless. Supposing, therefore, that there is no necessity to preserve the endochrome, there is another feature to remember besides the preservation of contour, and that is, that the medium employed should not render the delicate cell-walls so transparent as to become ultimately invisible. In simple water Dr. Cooke found no difficulty in discerning the structure of the cell-walls after a period of not less than twelve years. So much cannot be said for glycerin. As a hint it may be added that empty fronds, both of Desmids and Volvox, stained of various colours, exhibit all the details in an unexceptionable manner.

Some time ago we ventured to predict that not even the total suppression of vivisection would satisfy the hysterical party. Our words are being fulfilled. It is voted cruelty to feed snakes with live rabbits, &c., and as they will not, as a rule, touch dead food, English naturalists will have to go abroad if they wish to study serpent life.

Lest the chemists should laugh at the biologists, it is proposed that the three chief mineral acids—the sulphuric, nitric, and hydrochloric – should be placed on the list of poisons, and their sale encumbered with red-tape precautions. This idea, if carried out, will no doubt wonderfully facilitate chemical research in England.

M. Pasteur has received the gold medal of the French Society of Agriculturists for his researches on fermentation and contagion.

The "Scottish Naturalist" for April contains the first portion

of a carefully written biography of George Don, of Forfar, the eminent botanist.

"Science" brings forward proposals for a revision of anatomical nomenclature, referring to "the care bestowed upon the language of modern chemistry." We devoutly hope biologists will never take the language of chemistry as their model.

The same journal gives a communication from Col. W. A. Ross, which, unless some occult error or oversight interfere, points the way to a modification of our views on the chemistry of anhydrous compounds.

We learn that Dr. Buchanan, the dealer in spurious diplomas, is now an inmate of the Eastern Penitentiary, Philadelphia.

The Faraday Lecture was delivered by Prof. Helmholtz on the 5th ult. The lecturer's subject was "The Modern Development of Faraday's Conceptions of Electricity."

M. J. Delaunay ascribes earthquakes to the passage of the larger planets through the cosmic groups of meteors. He predicts violent earthquakes for the years 1883, 1886, 1890-91, 1898, 1900-1, 1912-13, 1914, 1919-20.

According to Prof. Morselli, of Milan, suicide has increased in England at the rate of 57·7 per cent since 1836; in Prussia, at the rate of 32·2 per cent since 1816.

M. Charles Dufour, in a paper read before the French Association for the Advancement of Science, shows that the glaciers of the Alps, the Pyrenees, and the Caucasus are all receding.

The drainage of certain parts of Epping Forest, near Chingford Station, will probably lead to the extirpation of many forms both of animal and vegetable life. A similar catastrophe, on a far larger scale, will result from the projected drainage of the Everglades of Florida, a district whose flora and fauna are but very imperfectly known.

Prof. Du Bois-Reymond is about to publish the researches of the late Karl Sachs on the electric eel (*Gymnotus electricus*) of South America.

Dr. Delaunay takes as a test of intelligence the direction in which a person draws a circle or executes a rotatory movement. Those whose minds are more highly developed move the hand from left to right, as in the daily movement of the sun, whilst the dull and stupid take the opposite direction.